

PORTAGE CANAL
Waterway connecting Fox & Wisconsin Rivers
Portage
Columbia County
Wisconsin

HAER WI-104
WI-104

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

FIELD RECORDS

HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
U.S. Department of the Interior
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HISTORIC AMERICAN ENGINEERING SURVEY

PORTAGE CANAL

HAER No. WI-104

Location: Waterway connecting the Fox and Wisconsin Rivers in the City of Portage, Columbia County, Wisconsin.
UTM: 16/303476/4826025; 16/300676/4823075; 16/302725/4823675 (USGS quadrangle: Portage, WI)

Dates of Construction: Initial construction and dismantling: 1849-51, 1959-60
Dates of replacements or significant modifications:
Portage Canal: 1858-59, 1875-76, 1891-92, 1897, 1927
Portage Lock: 1877-78, 1880, 1892-93, 1900, 1926-28
Ft. Winnebago Lock: 1858-59, 1874-75, 1890, 1900-01, 1936

Designer: Milwaukee District, U.S. Army Corps of Engineers

Builders: Portage Canal: Conro, Starke & Co. and Milwaukee District, U.S. Army Corps of Engineers (after 1873)
Portage Lock: M.E. White Company, Chicago (1926-28)
Fort Winnebago Lock: Milwaukee District, U.S. Army Corps of Engineers and S.A. Harrison (1890)

Present Owner: The structure is owned by the State of Wisconsin and administrated by the Wisconsin Department of Natural Resources, 101 South Webster, Madison, WI 53707-9721.

Present Use: The Army Corps of Engineers closed the structure to navigation in 1951, and it is currently not in use.

Significance: The Portage Canal gains significance as part of the Fox Waterway which operated as a complete facility between the late 1850s and 1951. The canal's components are representative of canal construction for the periods in which they were built. The improvement of the canal and waterway by the state with a federal land-grant, state-supported private enterprise, and federal government was a common sequence for the development of internal improvements. At the west end of the canal, the Portage Lock was tied into a levee system which prevents overflow of the Wisconsin River into the adjacent lowlands. The construction and maintenance of the levee reflect the operation of local, state, and federal government laws regulating navigation and flood control. They were significantly altered through time, affecting the treatment of the levee. The 1920s improvements along the canal were in part stimulated by strong contemporary interest in deep channel navigation.

Project Information: The documentation represents the partial fulfillment of the Memorandum of Agreement among the Army Corps of Engineers, the State of Wisconsin, and the City of Portage necessitated by the improvement of the Portage Levee crossing the west end of the canal.

THE LOCATION AND SETTING OF THE PORTAGE CANAL

The two mile-long Portage Canal links the Fox River to the Wisconsin River near the head waters of the Fox in the City of Portage, Columbia County, Wisconsin. The Portage Canal lies along a low, marshy sand plain at the summit level or highest point of both portions of the waterway, the Portage to Green Bay section along the Fox River and the Portage to Prairie du Chien section along the Wisconsin River. The rather unique geographical setting at Portage stimulated the development of the two rivers for navigation. Striving to create a navigation channel connecting the Great Lakes and the St. Lawrence and Erie Canal to the Mississippi and Gulf of Mexico, the State of Wisconsin began to improve the waterway in 1849 (Wisconsin Board of Public Works 1850). Although promoters of the waterway had intended to improve both the Fox and a portion of the lower Wisconsin River, work on the Wisconsin ceased by the 1880s. Hence, the waterway is denoted as the Fox Waterway or the Fox-Wisconsin Waterway as well as the Fox River Improvement (figures 1-4).

The improvement project encompassed four components along physically distinct sections of the Fox Waterway (figures 2-3). The improvement of the Lower Fox resulted in the gradual development of a slack water system in which the natural fall of the river was altered to a series of steps by the construction of dams which created pools between them. Short canals with one or more locks lifted boats around the dams between the pools. Originally, navigation of the Upper Fox was to be accomplished by dredging and cutting channels across the sharp bends of the river. This section of the waterway was gradually altered to a slack water system. The Portage Canal united the Fox to the Wisconsin. A navigation channel along the Wisconsin River was to be created by the construction of wing dams and dredging. This improvement strategy for the Fox-Wisconsin waterway was altered several times during the period of the its operation (Meindl 1991: 9).

The Fox River, then, is divided into the Upper and Lower Fox. Connecting the Portage Canal to Lake Winnebago at Oshkosh, the Upper Fox flows for a distance of approximately 137 miles and descends relatively gradually at 40'-0" or 5" to the mile from Portage (figures 3-4). The Fox River originates in the marshes in northeast Columbia County and northeast of Portage. It curves northwest toward Portage where it abruptly turns northeast toward Green Bay within 1.5 miles of the Wisconsin River. This portion of the Fox flows through three small lakes, lakes Buffalo and Puckaway and Lake Butte des Morts which also connects to the Wolf River near Winneconne. Between 70' and 300' wide, the shallow river flows between relatively low banks. It meanders through a level, glacial landscape which includes peat marshes, muck, and fine silty and sandy loams with poor drainage. During periods of significant high water caused primarily by high precipitation, the river floods the surrounding marshes to a depth of 3' to 5' over an area as great as two to five miles wide. When protected from overflow and drained, these marshes become productive agricultural lands. When dredging failed to maintain an adequate channel in the sandy river bed of the Upper Fox, the construction of low dams eventually established a slack water system along the Upper Fox in the 1870s. Because of the level terrain, they were developed as navigation rather than power dams. The Upper Fox flows through a rural landscape of agricultural fields, marshlands, and wooded areas connecting at

widely spaced intervals the small trading centers of Omro, Eureka, Berlin, Princeton, Marquette, Montello, Packwaukee, Endeavor, and Portage (Kabat 1957: 18; Whitbeck 1915: 14).

The Fox River flows into Lake Winnebago at Oshkosh and exits into the Lower Fox in two channels at the north end near the cities of Neenah and Menasha. The government dam at Menasha controls the depth of the water flow along the Lower Fox. Lake Winnebago serves as a storage reservoir for the maintenance of navigation and power during periods of low water and for the reduction of the level of spring floods. The Lower Fox drops an abrupt 168' in thirty-nine miles between Lake Winnebago and Lake Michigan at Green Bay. Between 300' and 3,000' in width, it flows between high banks and crosses eight series of rapids. A system of channels and seventeen locks provide access around the navigation and power dams. The Lower Fox flows through a more urbanized area than the Upper Fox connecting Neenah, Menasha, Kimberly, Little Chute, Combined Locks, Kaukauna, De Pere, and Green Bay. Its dams provide power to the pulp and paper mills and other industries of the lower valley (U.S. ACE¹ [Report] 1839-1963 [serial 1278, S. Doc. 16, 1867: 2; serial 9664, H. Doc. 212, 1932: 5-6]; Whitbeck 1915: 17-19).

The Wisconsin River flows generally south from its source in north central Wisconsin, curves abruptly southwest and away from the Fox River at Portage, and runs southwest 118 miles to the Mississippi River at Prairie du Chien (figure 1). The Wisconsin River lies 6' to 7' higher than the Fox River at normal flow. For this reason, water moves east through the canal from the Wisconsin to the Fox. Before the construction of levees along its banks, the Wisconsin flooded the lowlands and occasionally flowed across the portage into the Fox during high water. Prior to the construction of dams in the twentieth century, the Wisconsin River was a shallow river with multiple channels separated by small islands. Although one of these channels retained a depth of 5' to 6', it usually followed a crooked and changing course. The Wisconsin River flows over a bottom of course sand. Although its sand bars were generally permanent in their location, they altered frequently in their size, shape, and depth of water above them. Obstacles or an expansion in the width of the river quickly became the nucleus around which a sand bar formed. This characteristic and the sinuous course of the channel eventually frustrated the development of a navigation system along the Wisconsin (General Engineering Co., Inc. 1991: 5; U.S. ACE [Report] 1839-1963 [serial 1278², S. Doc. 16, 1867: 27]).

Measuring 2.12 miles in length, the Portage Canal connects the two rivers in the City of Portage (see figures a-d, 16; photograph WI-104-33). Encompassing 36.07 acres, the canal property was listed on the National Register of Historic Places in 1977. The Portage or Wisconsin River lock is located at the west end of the canal (figure a-b) and is incorporated into the Portage Levee (figures 15-16) which follows the east bank of the Wisconsin River in the City of Portage and in

¹ ACE refers in the citation section to the Army Corps of Engineers.

² Serial volume 1278 includes Major G.K. Warren's report on the Wisconsin and Fox rivers.

the towns of Lewiston to the northwest and Pacific to the southeast. The city's commercial area lies to the north of the canal at this west end, and a small industrial area is located to the south. In 1993, portions of both areas were placed on the National Register of Historic Places as the Portage Retail Historic District and the Portage Industrial Waterfront District (McKay 1993a; 1993b). Residential districts occupy much of the area along the canal between Adams and Townsend streets and the Milwaukee, Chicago, and St. Paul Railroad tracks to the northeast (figure b). About two-thirds of the canal's length, the area between the railroad tracks and the ruins of the Ft. Winnebago Lock at the east end of the canal near the Fox River (figure c), has a rural landscape with scattered residences, wooded areas, and marshlands. Trees overhang the canal along much of this distance. Constructed in 1832, the Indian Agency House which stands immediately to the northwest of the lock was entered onto the National Register in 1972. The site of Fort Winnebago occupies a hill across and above the Fox southeast of the canal's entrance into the river (figures 6, 8-9).

The precise width of the right-of-way along the canal property has been periodically questioned primarily because of encroachments upon it. Giving the state title to the property, the Wisconsin Board of Public Works selected the right-of-way for the canal from lands granted by the federal government on July 3, 1851. Additionally, in September 1853, 36.07 acres on both sides of the Fort Winnebago Lock were reserved for waterpower from the sale of the Fort Winnebago United States Military Reservation for the canal (U.S. ACE 1958-59 [map]). The United States eventually regained the property through a deed dated September 18, 1872 from the Green Bay and Mississippi Canal Company. L.M. Mann, assistant engineer of the Army Corps of Engineers, surveyed the tracts in 1901 (U.S. ACE 1901). His 1901 report described the then approximately twenty-two acre Canal Reservation (figure 8) and the 190 foot wide right-of-way along the canal which extended southwest from the canal reservation to the Wisconsin River (figures 9-10). The original description included a reference to a towpath, probably placed along the north bank of the canal. In the city limits, the canal right-of-way extended 40 feet on the left and 150 feet on the right side of the inside top of the towpath along the north or left bank. Although the waterway was intended for steamboats, the towpath appears to have been built. And, it was used prior to 1876 when the Army Corps enlarged the canal (Schultz 1941). The report further indicated that the lot lines of the private property extended across the government land as far as the canal. Encroachment by dwellings and outbuildings and, west of Jefferson Street, by commercial buildings occurred west of the Milwaukee, St. Paul, and Chicago Railroad bridge (figures b, 16).

By 1912, Major Charles Bromwell of the Milwaukee District of the U.S. Army Corps of Engineers concluded that the government possessed no title to lands in the Grignon Claim and section 8 southwest of the Canal Reservation at the west end of the canal. The United States granted only odd sections to the state in 1848. The state never took steps to legally confirm the lands selected for the canal by the Board of Public Works in 1851 which traveled through even sections in the City of Portage. Bromwell concluded that the Corps had no interest in lands adjacent to the canal except for the use of a strip necessary for repair of the revetments or walls along the canal and the two locks. A 1948 study confirmed this conclusion (East Central Wisconsin Planning Commission 1948-85 [file:

Portage Lock Correspondence)).

The U.S. Army Corps of Engineers transferred the canal property by quitclaim deed in 1961 and 1972. The deed described: "A strip of land including the United States Canal and 190 feet wide [tract]..." (Wisconsin Department of Natural Resources (WDNR), Southern District 1946-92 [File: Portage Canal, 1979-81]; WDNR, Facilities and Lands 1958-97 [file: Portage Canal, 1958 copy of doc. 3D8165, p. 71, vol. 288, Columbia County Register of Deed]). Although each investigation appeared to render a clear conclusion, the location of the two boundaries defining the limits of the canal property remained unclear at least in part because the original boundary definition threatened the ownership of a significant number of buildings in the retail and industrial area. As late as 1979, the Portage Canal Society requested a review of the land description associated with the title to the canal. In 1980, the Wisconsin Attorney General concluded that the state did not have title to lands outside the canal because of the long-standing encroachment of commercial and residential properties onto the strip of land (quoted in Kleist 1985: 15). In 1981, Governor Lee Dreyfus directed the Department of Natural Resources to complete a certified survey. Completed June 21, 1983, this survey conducted by Bridwell Engineering Company, Inc., Madison provided a right-of-way of 75 feet across the property from the centerline of the Fox River to the north line of the Wisconsin River in part of government lots 8 and 9, section 33, T13N, R9E; part of government lots 6 and 7, section 4, T12N, R9E; part of government lots 5 and 6, section 8, T12N, R9E; and part of the Grignon Claim No. 21 in sections 4, 5, and 8; all in the City of Portage and including a total of 21.2 acres (Bridwell 1983).

SIGNIFICANCE OF THE PORTAGE CANAL AND THE ORGANIZATION OF THEMES

The historical significance of the Portage Canal lies not in whether it succeeded financially as a carrier of goods from and through the Fox Valley, but in what the structure represents. The canal is historically associated with several related areas of water resource policy. It gains National Register significance as part of the Fox Waterway. State, private, and finally federal agencies developed the waterway in the third quarter of the nineteenth century to construct a transportation corridor connecting the Erie Canal and Great Lakes via the Wisconsin River to the Mississippi. Because the direct role of the federal government in transportation improvements remained a constitutional dilemma until the Civil War, the states and less often private enterprise continued as the primary agencies in waterway improvements. The Army Corps of Engineers completed studies determining the feasibility of navigation but did not usually engage directly in the supervision of such projects until after the mid-nineteenth century. But, after the Civil War, navigation became a recognized area of federal involvement. The development of the Portage Canal and Fox Waterway reflected this shift in policy.

During the canal's initial conception and development in the 1820s into the early 1850s, a waterway connecting the Great Lakes to the Mississippi River appeared to provide the most efficient method to transport goods and settlers to the Upper Midwest. Transportation by canals and improved waterways was heavily promoted

during the period between 1815 and the 1850s as significant settlement and commercial development west of the Appalachians required transportation improvements. The growth of commercial wheat agriculture and trade centers in Wisconsin depended on the movement of goods to the Great Lakes and eastern markets. There were major waterways developed during and after this period which did move a significant amount of commerce between the East and Midwest (Taylor 1951: 169; Wyatt 1986 [vol 2, sec. 2, transportation]: 1-3). Before the rapid displacement of water transportation by the railroad which occurred in most areas during and immediately after the Civil War, water routes remained a reasonable means to move particularly bulk goods.

When the Wisconsin River did not prove susceptible to navigation improvement in the 1880s and the Fox-Wisconsin Waterway would no longer connect the Great Lakes to the Mississippi, the U.S. Army Corps of Engineers developed and maintained the Fox Waterway to provide low cost, local transport of goods to and from central Wisconsin. The Portage Canal then became the west end of the waterway. Although carrying limited cargo by the late nineteenth century, the Fox Waterway and similar local waterways were viewed as significant by contemporaries because their lower rates helped reduce railroad costs.

Shortly after the turn of the century and especially during World War I, the railroad lines no longer possessed adequate facilities for the transport of goods between America's major trading centers. The federal government then encouraged the reintroduction of bulk commodity shipment by water and later began the development of deep waterways adequate for the movement of contemporary vessels. The government first introduced this program to the lower and later to the upper Mississippi and the Illinois River. Local spokesmen also advocated a similar program for the Fox and Wisconsin in the 1920s.

The existing concrete Portage Lock which was built between 1926 and 1928 was constructed so that it could serve as part of a deep waterway channel. It is similar to the concrete locks with hand-operated gate mechanisms erected along the Lower Fox under the U.S. Army Corps of Engineers in the 1930s (Richards 1995: WI-83/21). This lock; its associated canal with traces of its wood revetments; and the remains of the Fort Winnebago Lock, erected as a combination lock similar to others along the Fox Waterway by the 1870s, together reflect the initial developmental phase of waterway improvement and its later role in transportation in the Upper Midwest. The Portage Lock represents the only concrete lock along the Upper Fox and the first of five along the Fox Waterway.

Additionally, the Portage Lock provides an important link in the Portage Levee system which protects the City of Portage and adjacent towns of Lewiston and Pacific from flooding by the Wisconsin River (U.S. ACE, St. Paul District 1992 [1993-94]: 6). The development of the Portage Levee is typical of the piece-meal local, state, and federal flood control programs which emerged during the nineteenth and early twentieth centuries. The federal government only gradually acknowledged its role in the flood control as well as other water management issues as the twentieth century progressed. Flood control along the Wisconsin River at Portage shifted from the action of local agencies to the occasionally uncoordinated involvement of local, state, and federal agencies, to oversight

primarily by the state, and finally to local, state, and federal cooperation.

The following text places the Portage Canal within its historical context as part of the movement for the development of the nation's waterways by state and private agencies between 1815 and 1860s. It traces the federal government's position in waterway improvements by examining the role of Army Corps of Engineers in navigation in the nineteenth and first half of the twentieth century. The rapid expansion of the railroad network in the 1860s and 1870s strongly affected operations along the Fox Waterway. However, the state's constitution which prohibited the support of internal improvements also strongly affected the initial success of the waterway. The context examines the intended and actual role of the canal and waterway in the movement of goods. The upper end of the Fox Waterway did play an important role in transportation after its initial completion in 1856 through the 1870s prior to the completion of the railroad network in eastern Wisconsin. The efforts to revive waterway transportation as deep channel navigation in the twentieth century heavily influenced the type of construction utilized in the replacement of the Portage Lock in 1926. The technology reflected in the canal's construction, the concrete Portage Lock at the west end and the remains of the Fort Winnebago composite lock at the east end of the canal, is visible along the remainder of the Fox Waterway. However, the Portage Canal represents the only canal structure along the Fox Waterway which received revetments. The remaining canals were constructed without revetments to provide navigation access around the dams. Because the Portage Lock is an integral element in the Portage Levee, the context examines the federal government's role in flood control and investigates the ways in which local, state, and federal agencies resolved flood control issues at Portage.

CANALS AND RIVER IMPROVEMENTS: THE INTERNAL IMPROVEMENT PROGRAM IN THE NINETEENTH CENTURY

State and Federal Roles in Canal Development

Unlike their European counterparts which were extended through economically viable areas, most of the American canals were developmental. They were constructed through sparsely populated areas to assist settlement and the establishment and expansion of commerce. It was not that Americans of the first half of the nineteenth century were unable to produce a surplus or that markets did not exist. Wheat exports to Europe had grown significantly during the Napoleonic Wars and soon expanded to include the West Indies and nations in Central and South America.

The distances between production and markets were great, and, except across central New York, the Appalachian Mountains created an added barrier to trade. Until the mid-1820s, agricultural products such as wheat, flour, butter, pork and pork products, and lead from the Midwest were sent down the Mississippi and shipped from New Orleans to the East Coast and foreign ports. Before their improvement, the Des Moines and Rock rapids impeded commerce to the Upper Midwest. Less bulky, more valuable, finished goods were usually transported by

wagon across the Appalachians in Pennsylvania. This shipment was time-consuming, expensive, and for some agricultural goods often resulted in spoilage during the South's hot summers. Thus, high transportation costs of the surplus absorbed the profit from their sale. Lack of access to eastern markets created a local agricultural surplus which significantly reduced profits gained from goods produced in the region. In newly settled areas, these limitations tended to retain the economy near subsistence level. Likewise, eastern industries were unable to reach western markets where high demands for their goods existed. Then, even the less efficient, early canal systems such as the Pennsylvania Mainline completed in 1834 offered a more viable route between East and West than overland or the circuitous Mississippi and Atlantic route.

Completed between 1817 and 1825, the Erie Canal which served as part of the Upper Midwest's link to the East became the foremost example of the developmental canal. The state constructed the canal through sparsely settled territory with the anticipation that it would stimulate sufficient trade to justify the expenditure. Although a developmental canal, it not only stimulated rapid economic development of Upstate New York and broad tributary areas but, unlike most canals of this type, it earned considerable revenues (Goodrich 1960: 284; Goodrich et al. 1961: 217, 222-25, 243, 247; Conzen and Daniel 1990: 10, 39; Taylor 1951: 34, 158-61, 168-69; Rubin 1961: 6, 96-97; Hoops 1986: 15-19).

Without existing trade opportunities, income gained from the use of the newly constructed improvements awaited the growth of the agriculture and industry which the waterway was constructed to foster. For this reason, those who supported the construction of improvements frequently failed to gain a large return for their investment. As well, developing areas such as the Midwest during the first two-thirds of the nineteenth century often lacked a sufficient concentration of capital resources to support such large-scale undertakings. Precisely because gain on this investment was belated and too limited for the risking of capital by private investors, these areas required at least partial government sponsorship of internal improvements to provide the necessary financial backing. Between 1815 and 1860, 62 percent of canal funding came from government sources.

Although canals were often unprofitable as direct investments, their presence promoted significant early expansion in population, agricultural, and small industrial shops; increased trade; expanded employment; stimulated growth in property values; and created the development of a higher tax base. Once trade became established, both the East and Midwest benefitted from commercial specialization, expanded markets produced by less expensive agricultural and industrial goods, and a greater real income. As western settlement and investment opportunities grew following trade access, land values rose. Additional responses to access to comparatively inexpensive transportation facilities and expanded trade in the Midwest included the development of trade centers and small industrial centers and the establishment of commercial facilities such as wholesalers, warehouses, transshipping operations, and more sophisticated financial support systems. Thus, because the government provided access to markets and created broad investment opportunities, the public in general benefitted from such an improvement (Goodrich 1960: 277-79, 294; Goodrich et al. 1961: 4-5, 177; Armstrong 1976: 29). On the other hand, because benefits

were often diffuse, it was frequently difficult for contemporary supporters of improvements to establish if public assistance for improvements should be extended, how much it should be, and how great a loss should be sustained for the development to reach its full potential (Goodrich 1960: 284).

Despite the fear of concentrated wealth and special privilege in pre-Civil War America, the desire to accelerate economic development within a sparsely occupied, vast territory prompted the use of government funding sources. This developmental or booster ethic in fact led to a vast array of project promotion schemes involving all levels of government alone or in combination with private enterprise. Government involvement ranged from the provision of part or all of the capital to complete ownership of the improvement or sharing of ownership and operation with a private agency. State funding included capital subscriptions to stock, loans, or guarantee of interest or principal. Early federal funding was offered in the form of large land grants. Both federal and state aid might be provided directly. To ensure proper use of funds, mixed enterprises which included construction by private means and private subscriptions were preferred. Government support required the establishment of a regulatory agency, for example boards of public works or trustees, attempting to ensure proper expenditures, construction quality, and maintenance of work schedules (Goodrich 1960: 7-15, 267, 284, 294).

Rapid development of canal transportation had occurred in Great Britain after the construction of the Bridgewater Canal in 1765. Without necessary capital and engineering expertise, the comparatively flat terrain and short distances of Great Britain, and clear designation of the responsibility for waterway improvement, few canals and river improvements more than several miles long existed in the United States prior to the War of 1812. The total canal length was less than 100 miles by 1816. Most were short by-pass structures circumventing obstructions in a waterway. Two exceptions included the twenty-two mile-long Santee and Cooper Canal which connected Charleston to its back country in 1800 and the twenty-seven and a half mile Middlesex Canal between Lowell and Boston constructed between 1794 and 1804 (Shank 1982: 15-16; Taylor 1951: 32; Goodrich et al. 1961: 7).

As early as the 1780s, transportation improvements were not only significant for the development of trade and the economic growth which was so enthusiastically sought, but it was needed to draw together the remote back country and the East Coast into a political union. In the late eighteenth and in the first three decades of the nineteenth century, movement by waterways was the only viable approach to long-distance transportation. Freedom to navigate these waterways without toll or tax so that strong commercial ties might develop became a central means to unite East and West. This right was first incorporated in the Ordinance of 1787 which governed the Northwest Territory including Wisconsin. Articles I through VI which made reference to the navigation of waterways leading into the Mississippi and St. Lawrence became the foundation for the free waterway policy in the United States. Similar provisions were incorporated into the acts which admitted states into the Union after 1790. The Commerce Clause of the Constitution provided to the federal government the exclusive power to establish policy regulating commerce among the states and state tonnage duties.

In the 1824 case of Gibbons versus Ogden, Chief Justice John Marshall clearly established the interpretation of the Commerce Clause to state that citizens of one state possessed the right to freely travel the rivers and waterways of another state; that Congress rather than the states controlled all aspects of interstate commerce; and that as part of its ability to control commerce over the waterways the federal government had the right to improve these channels of commerce. Although concern about the constitutionality of federal sponsorship of internal improvements continued until the Civil War, waterway improvement gradually became the responsibility of the federal government (Hull 1967: 2-9, 47; Chorpene 1953: 985-86; Armstrong 1976: 25).

At the request of the Senate in 1807, Albert Gallatin, then Secretary of the Treasury, prepared a federal-level plan for internal improvements in 1808. It examined on-going improvement projects and provided a guide for the selection of future projects. He advocated a comprehensive system of waterway and road improvements connecting the eastern seaboard to the interior. The plan was to advance economic development of the trans-Appalachian West, provide for national defense, and further political unity. Gallatin proposed improvements along such waterways as the Hudson and Mohawk with canals to Lake Champlain and Lake Ontario and the Susquehanna, Potomac, James, and the Santee or Savannah rivers. As a result of this plan in 1809, Congress funded the Carondelet Canal which extended the Mississippi River from New Orleans to Lake Pontchartrain. Congress justified the structure as a military asset, allowing the passage of gunboats. This military justification for federal participation in navigation improvements received much usage in the nineteenth century.

However, before Gallatin's plan was implemented, the surplus monies earmarked for these projects in the federal treasury were absorbed by the War of 1812. In 1818, Congress passed a resolution affirming its right under the constitution to appropriate funds for roads, canals, and waterways. Secretary of War John Calhoun issued a plan similar to Gallatin's in 1819. He added projects which affected waterways further west and cited the military and commercial necessity for the federal development of such channels of communication. Although a clear federal role was defined at this early date and Congress hotly debated the issue, the federal government did not itself underwrite a significant portion of the plan.

The outcome of Gibbons versus Ogden permitted the 1824 passage of the General Survey Act which incorporated some of the general recommendations of the 1807 and 1819 reports. This act directed the president to initiate surveys for the route of canals, waterways, and roads which would facilitate the improvement of national-level transportation. It also authorized the employment of two civil engineers and officers of the Army Corps of Engineers for this purpose. John Quincy Adams of the Whig Party using this authority directed the Army Corps of Engineers to select for consideration such waterways which neither the resources or jurisdiction of a single state could improve. But, in general, the actual completion and operation of the improvements became the responsibility of the states. The election of Andrew Jackson of the Democratic Party in 1830 halted significant federal support of waterway improvement until the 1850s. Under the party's strict interpretation of the Constitution, federal improvement of

waterways obstructed the rights of each state to pursue the development of their individual transportation networks. The federal government was not to engage in public works which might produce revenue, for example support state or private projects which charged tolls. Such projects opened the door to the patronage of special interests. State and sectional rivalries further blocked the implementation of a federal transportation plan. In general, only those transportation corridors which contributed to the military security of the nation received support (Goodrich 1960: 38-47, 265-66; Armstrong 1976: 25, 30; Hoops 1986: 16; Goodrich et al. 1961: 5-6; Chorpening 1953: 988; Hull 1967: 10-13).

Development Cycles in Canal Funding and Construction: 1815-60

Primarily variations in the interpretation of the federal role in internal improvements; available funding sources and financial climate; the location of canals; and existing transportation technology define three overlapping cycles of significant canal investment and development. Although certainly affected by the general condition of the economy, canal investment often outlasted multiple business cycles and frequently fluctuated independently of them. These cycles occurred between 1815 and 1834, 1834 and 1844, and 1844 and 1860 (Goodrich et al. 1961: 169-70; Taylor 1951: 37). Beyond indicating the lack of correlation between upswings in the economy and rises in canal investment, the analysis provides some additional insight into the causes of the surges in canal construction in this antebellum era and offers some generalization about why waterway improvements gained such importance, which agencies constructed them, what actual benefits they provided, and who eventually benefitted. Canal construction during this pre-Civil War era required a great deal of time and often encountered problems which the sponsor could not anticipate. The technological and financial problems often meant that the sponsor secured a canal project and associated benefits different from the ones initially planned (Goodrich et al. 1961: 174; Goodrich 1960: 265, 287-89, 294).

The success of the Erie Canal which was evident by 1823 stimulated the construction of many of the canal and waterway improvements completed between 1815 and 1834. Construction in this period composed about one-half of the canal mileage and 31 percent of the improvement investment in the ante-bellum era. The federal government provided limited support to waterway improvements until 1830 when it had expended only 1 percent of the total monies. After this date, it generally withdrew from the development of specific transportation routes and left this role to the states. Sectionalism tended to limit its active role in waterway development. Congress did approve limited, sporadic funding for river and harbor improvements. Rather than become directly responsible for total funding or project oversight, it granted funding to the states. In the late 1820s, Congress provided a small number of land grants. For example, Illinois, Indiana, and Ohio received alternate sections of land along the corridor of their proposed improvements in 1827 and 1828. Between 1802 and 1820 and in 1841 for Iowa, the federal government gave a small percentage of the income from public land sales to the territory or state for improvement programs. It also subscribed to the stock of several private canal companies.

The federal government remained sufficiently remote from internal improvements that an English observer attributed the responsibility for these works to the states in 1838 (Stevenson 1838: 188-89). The states or a mix of state sponsorship and private enterprise assumed the primary role of waterway improvement. Prior to the mid-1840s, very little capital was available for private investments in the United States. Many of the canals received most of their funding, a little over 70 percent, from state and municipal governments. These governments derived their funds from the sale of bonds to eastern financial institutions and to a lesser degree to the London markets. Continuous access to funds during an economically prosperous period meant that construction was rarely suspended for significant periods of time. Canal commissioners or a board of public works frequently managed the finances of state and state and private enterprise projects.

Major canal construction began shortly after New York State initiated the building of the Erie Canal, connecting the Hudson River at Albany and Lake Ontario at Buffalo between 1817 and 1825. Although this project did not start the movement, its completion and significant generation of revenues by 1825 illustrated the ability of a state to construct such a project and prompted other states and private enterprise to risk the investment. Many of the canals built by the mid-1830s contributed to the economic development of the local areas which they traversed and in some cases the regions they served. However, these canals did not achieve the success of the canal that stimulated their construction. The Erie Canal generally carried far more tonnage, tapping vast areas in two regions. The Erie occupied the single gap across the Appalachian Mountain chain between New York and Georgia. New York State funded and built the project during a period of relative prosperity. While clearly a tremendous undertaking even for state government in the early nineteenth century, construction of a canal rather than improvement of a river created a more permanent and successful waterway. This approach eliminated some of the later maintenance problems. The canal directly connected the Great Lakes and its surrounding states with an existing urban area, operating well before the railroad perfected its connections between the East and the Mississippi Valley. Thus, although the state undertook a risk as it constructed a developmental canal, its project tapped a large region rich in natural resources. The Erie Canal also absorbed part of the western trade from the turnpikes. Even before the completion of the canal's construction in 1823, it began to show high earnings (Goodrich 1960: 13, 45-46, 51-52, 60-61, 69, 169, 265-69; Goodrich et al. 1961: 6, 25-26, 40, 67-69, 94, 104-105, 169-82, 183-89; Taylor 1951: 33-34, 39-40, 49, 378, 382; Chorpening 1953: 976, 990; Rubin 1961: 6; Armstrong 1976: 25; Shaw 1966: 261-64).

By 1826, an estimated 100 waterway improvement projects were extant or in the planning stages. By 1840, 3,000 miles of canals existed. Most of the seven interregional canals were begun in this cycle to capture the growing trade of a region's hinterland. Construction activity occurred along the eastern coastal region, tidewater, and into the Appalachians. Projects by the states of New York as well as Pennsylvania, Ohio, and Virginia accounted for a considerable portion of these early canal investments. Three of the early canals were begun to provide a route through the Appalachian Mountains as they competed with the Erie Canal for western trade, first of the Ohio Valley. For example, the State of

Pennsylvania hastily chose to construct the Mainline Canal between 1825 and 1834 over the mountains between Philadelphia and Pittsburgh. It later found that the only economically feasible approach to completion of the project was by the inclusion of a railroad portage. Supported by Maryland, Virginia, and the federal government, the building of the Chesapeake and Ohio began in 1828. The Ohio and Erie built on the west edge of the Appalachians beginning in 1825 represented a parallel response to secure the trade of the Ohio Valley. The James River and Kanawha Canal in Virginia was started in 1795 but reached only forty miles in length near Richmond. Its scope was enlarged in 1835. The economic and political rivalry between the states which initiated such construction remained at a high levels during much of the nineteenth century. Short, intraregional canals were also constructed to connect commercial centers or haul specific raw materials such as the Pennsylvania anthracite coal.

A second cycle of canal construction occurred between approximately 1834 and 1844. The period began with rapid economic development in the Midwest. Settlement especially around the Great Lakes led to a land boom and a tremendous influx of population which led to inflation in land and commodity prices and broad financial speculation. The completion of the Erie Canal to the Great Lakes permitted much of this population growth. When he vetoed the Maysville Road project connecting Maysville on the Ohio River with Lexington, Kentucky, President Jackson checked direct federal government involvement in internal improvement programs in 1830. It sporadically continued to fund water improvement surveys, and it did not suspend all federal support. In 1837, states received surplus funds which were generally applied to internal improvement programs. By legislation of 1841, the government granted 500,000 acres to each public land state and each newly formed state as it entered the Union. In addition, states secured sizeable loans for construction through the sale of bonds to eastern investment companies and increasingly in English and other foreign money markets. They continued to gain access to this funding with little difficulty until 1839. This source of funding permitted a rapid rise in the amount of canal construction between 1834 and 1840. Canal investment rose from 14.2 million to \$57.3 million between these dates.

The financial downturn of 1839 ended the availability of foreign capital, and canal investments dropped precipitously. Tight money markets produced a financial crisis in those states constructing canals, and improvement projects almost ceased by 1842. Unable to pay the debt charges with canal revenues, states began to honor interest charges through additional loans. Many of these states including Florida, Mississippi, Arkansas, Louisiana, Pennsylvania, Maryland, Indiana, Illinois, and Michigan repudiated a substantial portion of their debts. States such as New York and Ohio resorted to the then drastic measure of taxation to repay their loans. Without credit, completion of the projects became almost impossible. These states generally either transferred or sold the canal projects to chartered companies for project completion. Almost \$60 million of construction on existing projects remained incomplete by 1844.

A majority of the canals built during the second cycle between 1834 and 1844 were laterals to existing canals and interregional canals in the Midwest. These later projects sought to extend the Erie and Great Lakes network by connecting them to

the Mississippi and its major tributaries. Canal construction during the second period included the enlargement of the Erie Canal and construction of feeder lines to it which began in 1834 and 1836 respectively. Despite its large investments in the Mainline, Pennsylvania began building additional canals, mainly feeders, in 1836. In 1833, Ohio completed the construction of the Ohio and Erie Canal. It finished the Cincinnati to Dayton leg of the Miami and Erie Canal in the west section of the state in 1832, but the section to Toledo on Lake Erie did not reach completion until 1845. Indiana's portion of the Wabash and Erie connecting Toledo with Evansville extended 467 miles to become the longest artificial waterway in the United States. Although construction started in 1832, little work was completed until 1836 when a massive internal improvement bill gained passage. Illinois received a land grant to complete a canal across the state in 1822. However, it did not begin the Illinois and Michigan Canal which connected Chicago with the Mississippi along the Illinois River until 1836. Maryland and Virginia also considerably expanded their involvement with the Chesapeake and Ohio and James River and Kanawha canals in 1835 (Goodrich 1960: 134, 138-39, 141, 265; Goodrich et al. 1961: 8-9, 177, 182, 190-203; Taylor 1951: 46-47, 49-50, 374-76; Schaffer 1937: 93).

The final cycle of canal construction occurred at a much reduced rate between 1844 and 1860. By 1840, 3,326 miles of canal already existed. The majority of the projects were ones remaining from the second canal cycle. Sufficient domestic capital was available to fund the completion of canal projects. By the mid-nineteenth century, private accumulation of wealth and the growth of business organizations permitted an increasing contribution from this sector. It gained a major role in railroad development. When some state governments failed to find adequate funds to complete their improvement programs and some placed constitutional restrictions on their involvement, the federal government again contributed a share of the support in the 1850s.

This change in the relative level of contribution of federal to state support was initiated by the federal government's extensive support of the Illinois Central Railroad in 1850. It provided large grants of federal land, usually alternate sections six miles wide along the route of improvement, to assist with the construction. Where lands along this strip had been sold, the state received compensatory lands within nine miles of the improvement. Questions of constitutionality of this action were assuaged by doubling the price of the sections the federal government retained. In later improvement projects, lands were either directly granted to the states for their direct use or, in some cases, for redistribution to private companies. In this period, Congress usually defined the general corridor of the route and identified its terminus. While these grants were most often applied to railroad projects during an intense period of railroad building, state canal and river improvements also received such support. Additionally, the 1850 Swamp Act donated unsold swamp and overflow lands to the states for their improvement and sale. The proceeds were intended for application to state improvement projects. Between 1850 and the financial crisis of 1857, the federal government provided generous land donations to many projects, indicating that they were no longer required to be routes of national importance.

During this last period of canal construction, expansion rather than the initiation of construction along new waterways took precedence. The extensions to the Erie, the Chesapeake and Ohio, the Miami and Erie in Ohio, the James River and Kanawha, and the North Branch addition to the Pennsylvania Mainline were completed. Supervised by bond holder trusteeships, the Illinois and Michigan and Wabash and Erie canal projects were finished in 1848 and 1854 respectively. Constructed between 1853 and 1855 to connect Lake Superior with Lake Huron, the Saint Mary's Falls Canal eventually carried more traffic than any other canal in the United States. Additionally, economically viable improvements which had been poorly constructed and proved too small to carry the larger boats of the 1840s and 1850s were expanded.

Canal investments after 1840 included one-third of the funds expended on waterway improvement between 1815 and 1860. During the 1840s, 400 miles were added to waterway improvements but 123 miles were abandoned, and between 1850 and 1861 canal mileage lost an additional 225 miles (Taylor 1951: 52). The proven necessity to expend large sums to construct and particularly to maintain, repair, and enlarge a canal; the necessity to operate close to capacity to remain financially viable; the tremendous indebtedness caused in part by overinvestment in improvements between 1837 and 1839; competition with developing railroad lines which provided faster, more dependable, and more flexible service; closure during portions of the year because of freezing, flooding, or low water; and development of most of the long-distance natural waterway routes by the 1850s all contributed to severely diminished waterway improvement activity by the depression of the late 1850s (Goodrich et al. 1961: 183, 203-204; Goodrich 1960: 65, 169-173, 267-71, 275; Hull 1967: 19, 22; Taylor 1951: 383, 386; Armstrong 1976: 29-30).

Because waterway improvements no longer appeared to be competitive with railroads, Segal (in Goodrich et al. 1961: 183) denoted canal construction in the 1840s and 1850s as "an echo phenomenon." As Taylor observed, new construction precipitously declined and portions of some poorly conceived projects closed as early as the 1840s. However, many waterway improvements operated on a relatively prosperous basis carrying bulk products as late as 1860, and several reached peak operation in the several decades after the Civil War. Tonnage on the Erie did not peak until 1880. Well-placed Pennsylvania canals such as the anthracite canals carried a considerable amount of local tonnage as late as the Civil War and in some instances into the 1870s or 1880s. The two Ohio canals, the Ohio and Erie and the Miami and Erie, carried considerable local tonnage into the 1850s as railroads were rapidly completed across the state. The Illinois and Michigan Canal connected the Chicago River five miles from Lake Michigan to La Salle on the Illinois River which flows 213 miles southwest to the Mississippi River. Opening in 1848, the canal and its feeders contributed significantly to the expansion of Chicago and the agricultural development of the region along the canal until the late 1870s. The original land grant to the project stimulated the platting of Chicago in 1830 to permit the sale of lots supporting the project. While the 450 mile-long Wabash and Erie which connected the Ohio River with Lake Erie did significantly contributed to the opening of the northern prairie, traffic remained light on the southern section which closed in 1860 (Taylor 1951: 34, 40, 45-48, 55; Conzen and Daniel 1990: 39; Peine and Neurohr 1981: 7; Larson 1979: 72, 185-97; Swanson 1984: 41).

When success is measured in tonnage or contribution to early settlement and agricultural and industrial development, waterway improvements did generally have a significant impact on economic growth of the Midwest into the post-Civil War period. This impact on local and regional trade together with the booster spirit, the phenomenal drive to people and economically develop new and growing areas, provides insight into the forces which continued the long-term, but less successful waterway improvements such as the Fox-Wisconsin.

Waterway Promotion and Improvement in Wisconsin

Existing as part of the Michigan territory, Wisconsin began the promotion of its waterways in 1829 late in the speculative first cycle of canal investment between 1815 and 1834. States adjacent to Wisconsin invested heavily in waterway improvements. During the financial crisis of the late 1830s, many of these states defaulted the loans supporting their projects. Private investors and individuals active in Wisconsin territorial government heavily promoted improvements connecting the Erie and Great Lakes with the Mississippi as funds for loans and federal monies became much less abundant. In 1836, Wisconsin's Military Road uniting Fort Howard with Fort Winnebago and Fort Crawford was one of the few main transportation routes across the territory. Few shipments of grain came east from Wisconsin until 1841 while western wheat from other states entering the Port of Buffalo at the west end of the Erie Canal had grown from 3,640 bushels in 1829 to 500,000 bushels in 1837. If Wisconsin farmers were to sell their cash wheat crop, they would require access to markets from the interior of the territory.

Captain T.J. Cram outlined three alternative routes connecting the Mississippi with the Great Lakes in his 1840 report following his survey: 1) from the Mississippi River, along the Wisconsin River, to "the portage," and along the Neenah or Fox river to Green Bay; 2) from the mouth of the Rock River at the Mississippi, up the Rock River to its head of navigation, by canal to the south bank of Lake Winnebago, and up the Fox River in Wisconsin to Green Bay; and 3) from the mouth of the Illinois River at the Mississippi, up the Illinois River to its head of navigation, and by a canal along the unnavigable portion of that river and the portage to the southwest shore of Lake Michigan through the site of Chicago (figures 6-7). Cram recommended sufficient improvement to permit the use of steamboats for the chosen route (U.S. ACE [Report] 1839-1963 [serial 359, S. Doc. 318, 1840: 2-3).

Thus, several routes joining the Mississippi with the Great Lakes competed for federal funding. The State of Illinois had begun the improvement of the third alternative by building a portion of the Illinois and Michigan Canal connecting Lake Michigan with the Illinois River. The state's financial plight in the late 1830s delayed the completion of this project until 1848. The first alternative, the Fox-Wisconsin Waterway of which the Portage Canal is a part, had received its advocates, primarily Morgan Martin, as early as the late 1820s when Wisconsin belonged to the Michigan Territory. It was being heavily promoted.

Byron Kilbourn, town promoter and civil engineer, favored a variation of the

second alternative. Receiving a charter in 1837, this route connected the Great Lakes to the Mississippi by the Milwaukee and Rock rivers with a forty mile, intermediary canal. Lead from the mines of southwest Wisconsin was to be shipped over this route to Milwaukee. In 1838, Captain Cram had also investigated its feasibility and surveyed the Rock River Haven or Madison's Four Lakes and the Catfish or Yahara river to serve as a feeder to the canal. In the same year, Congress provided support for the Milwaukee and Rock River Canal in the form of a land grant of alternating sections which totaled 165,000 acres. It does not appear that this donation resulted from the 1837 distribution of the federal surplus funds. However, the grant stipulated that sections held by the federal government were to sell at \$2.50 per acre rather than \$1.25 to compensate for the loss of land. Beginning in 1839, one mile of canal and a dam were constructed along the Milwaukee River for this project. The State of Illinois had also begun the improvement of the lower part of the Rock River. Without adequate land sales, the company never received sufficient funds to continue the project. The state legislature eventually used the funds derived from the sale of the federal land grant for educational purposes.

The directly competing river improvement project promoted by territorial Governor James Duane Doty linked the Rock River to Lake Winnebago and the Fox River at Fond du Lac. It was Cram's second alternative. This action diffused the government's attention over multiple projects. A land speculator in the area of Fond du Lac as well as Madison and other townsites along the Fox, Doty held a vested interest in the Fox to Rock River route. Planning a network of improved waterways across southeast Wisconsin, he also contemplated improvement of the Yahara through the Fourth Lake and connection of it with the Wisconsin by canal to place his townsite at Madison on a through water route. Finally, he had considered connection of the Fox River with the Wisconsin via Duck Creek which empties into the Wisconsin south of Portage. The Army Corps of Engineers under the direction of J.H. Wilson again surveyed Doty's Rock River improvement project in 1866 (Mermin 1968: 6, 10-12, 194-95; Larson 1979: 49, 73-74; Wisconsin Governor [Executive Records] 1840-1914 [1863-68, file 2, box 10]; U.S. ACE [Report] 1839-1963 [serial 359, S. Doc. 318, 1840: 2-3, 16-23; serial 346, H. Doc. 102, 1839: 1-11; serial 347, H. Doc. 175, 1839: 1-4]; Smith 1954: 181-89).

One additional existing water improvement in Wisconsin, the Sturgeon Bay and Lake Michigan Ship Canal, received funding much later in the century. It reduced the trip from Green Bay to Chicago by 100 miles. The improvement crosses the peninsula between Green Bay and Lake Michigan at Sturgeon Bay. Although a

³ Cram's report also included an 1839 map of the three routes (figure 7).

⁴ The document was prepared by J.B. Petitval with letters from James D. Doty.

⁵ This document is Doty's letter to the Committee on territories in which he promotes the Fox-Wisconsin and Fox-Lake Winnebago-Rock River routes as well as the Milwaukee-Rock River route.

company incorporated to complete the project as early as 1854, a second formed by a combination of lumber interests secured the 200,000 acre land grant in 1866. The project was finally undertaken between 1872 and 1881. The Corps surveyed the canal site in 1871 and completed the associated harbor of refuge in Lake Michigan in 1882. Purchasing the waterway in 1893, the federal government gradually improved the canal and harbor during the 1890s and early 1900s and continues to operate the waterway. The additional river improvements along Wisconsin's northern rivers mainly transported lumber (Goodrich 1960: 147; Berquist 1991: 24-29; Shaw 1966: 261, 269; Schaffer 1937: 98; Wyatt 1986 [vol 2, sec. 2, transportation]: 2-3; Larson 1979: 180-84; Kriviskey and Zeitlin 1983: 10-11; U.S. ACE [Report] 1839-1963 [serial 359, S. Doc. 318, 1840: 1; serial 1559, H. Doc. 2, 1872: 6]).

The financial difficulties created by the other internal improvement programs resulted in the move to divorce state government from fiscal responsibilities for transportation and other public works in Wisconsin and adjacent northern midwestern states. Nineteen states amended their constitutions after the 1830s to limit their debt. Article VIII, Section 10 of Wisconsin's state constitution of 1848 did not permit the accumulation of state debt for internal improvements or the extension of loans to assist private companies to construct them. Although periodically challenged, this clause thwarted funding of transportation and other improvements well into the twentieth century. However, the constitution did permit the state to appropriate to projects revenues gained from land grants. It also passed laws enabling local governments to provide assistance to transportation improvements, primarily railroads. The legislature enacted eighty such laws in the 1850s. At statehood in 1857, Minnesota passed legislation forbidding government involvement in public works programs and state assistance to private entities except as trustees of federal grants. But, unlike Wisconsin, a constitutional amendment cleared the way for state assistance in 1858. Iowa's 1846 constitution placed a ceiling on the amount of state debt and prohibited the state's involvement in private investments (Goodrich 1960: 147-49; Taylor 1951: 377; Wisconsin, State of [Journal of Proceedings] 1848 [1869: 277]; Hurst 1964: 574-75; Mermin 1968: 21, 49).

The settlement and land sales of states bordering the Great Lakes: Ohio, Illinois, Indiana, and Michigan, grew significantly between the 1830s and 1850s. The tonnage of agricultural products shipped from the Midwest to the East also rose considerably in this period. The opening of the Erie Canal did significantly reduce transportation costs of goods from the Great Lakes region. As canals reached the agricultural hinterlands, shipments which had been sent down the Mississippi and then to the East Coast shifted to follow inland water routes. River improvements and canal routes in these states played a significant role in enlarging the area of trade with the East Coast. These waterway improvements provided the only outlet for goods early in the development of the Midwest. They later remained as a principle outlet for areas bordering the Great Lakes. Thus, given the climate in which states strove to rapidly develop newly settled areas of the Midwest, expedients which enhanced trade possibilities were heavily and sometimes feverishly promoted. Small settlements near waterways began to envision a growth compared to Buffalo, New York's rapid rise to commercial prominence (Goodrich et al. 1961: 230-33; Goodrich 1960: 279-80;

Merritt 1979: 158).

Municipalities, associated private investors, and politicians of territorial and state governments heavily promoted internal improvement programs to secure federal largess during the nineteenth and well into the twentieth century. Common forms visible beginning in Wisconsin's territorial period included memorials by the legislature to Congress. Overcoming the usual state rivalries, representatives from Wisconsin often joined with other states along the upper Mississippi River corridor to present a united voice for river improvements. As early as the 1850s, conventions, private business organizations, and commissions were created primarily to promote and lobby Congress for improvements funding. Representatives of these pressure groups often communicated with the Army Corps of Engineers about the feasibility of and support for certain projects. Because the Army Corps established the feasibility of improvement projects in their reports to Congress, the cooperation of this body was essential to securing support from the federal government. Their reports occasionally reflected the persuasive arguments of local groups promoting their favored improvement. Common arguments for improvements included the need to improve transportation to permit the passage of gunboats during times of war and the reduction of transportation costs to raise profits to regional farmers, merchants, and manufacturers. Such cost reductions would provide competition with the growing railroad network and thereby reduce their rates. Emerging just after the Civil War, this justification became a key argument for waterway improvement well into the next century (Tweet 1984: 64-66; Rathbun Associates 1984 (II): 8-9, 15; Tanner 1840 [1970]; Wisconsin, State of [Laws] 1848- [1863: 488-89; 1875: 678-79]; Atlas 1857).

The interchange between politicians and the Army Corps concerning the Fox-Wisconsin Waterway began early in its development. As early as 1838, James Doty communicated with Captain T.J. Cram of the Army Corps to find additional support for his project along the Rock River. One of Doty's letters establishing its importance was included in the Chief of Engineers reports of 1839 (U.S. ACE [Report] 1839-1963 [serial 374, H.Doc. 175, 1839: 1-4; serial 359, S. Doc. 318, 1840: 2-3, 16-23; Smith 1954: 175-76, 182-84, 189). In 1866, J.H. Wilson who was stationed at Davenport, Iowa, reminded the governor of Wisconsin of the necessity of united action to achieve national aid for the improvement of Rock River, Fox-Wisconsin Waterway, and the Upper Mississippi rapids (Wisconsin Governor [Executive Records] 1840-1914 [1863-68, folder 2, box 10; Wisconsin, State of [Journal of Proceedings] 1848- [1867: 20-22). By 1869, General Gouverneur K. Warren of the Army Corps, who was assigned to the examination of the Fox and Wisconsin rivers, personally assured Governor Fairchild that he would continue the three-year-old investigation of the Wisconsin River to establish a viable plan (Wisconsin Governor [Executive Records] 1869-70, file 3, box 10)). In 1874, Army Corps reports supported multiple connections between the Great Lakes and the Mississippi including the Fox-Wisconsin. These reports viewed them as mere extensions of the Erie Canal. William Windom of the United States Senate Committee on Transportation Routes to the Seaboard provided such an argument for the Fox-Wisconsin Waterway in that year. Its potential competitiveness with the Illinois and Michigan Canal and with the railroad for bulk shipments played a central role in the argument promoting the waterway (U.S. ACE [Report] 1839-1963

[serial 588, S.Doc. 307, 1874: 222-29; Wisconsin Governor 1840-1914 [1863-68 and 1871-79, files 2-3, box 10: Breese Stevens promotion, 1866, 1874]].

In 1856, Morgan Martin, Wisconsin politician and a main proponent for the Fox-Wisconsin Waterway in the late 1840s and 1850s, sought a unique manner in which to promote his partially finished project. He commissioned Samuel M. Brookes and Thomas H. Stevenson to complete eleven paintings of the project. Painting number 12 illustrates the mouth of the Portage Canal with the Wisconsin River in the foreground and the city rising in the background. The paintings at once celebrated a milestone in the completion of the project and illustrated the potential of the project to would-be supporters (Smith 1967).⁶

Between 1863 and 1885 as Wisconsin vied with other states for support of its partially finished improvement, the Wisconsin legislature sent a relatively constant stream of memorials to Congress affirming the importance of the enlargement of both the Erie Canal and of the Fox-Wisconsin to the prosperity of the Upper Midwest. Governor Fairchild was adamant about involving direct federal support. Following his 1867 message, the legislature responded with three memorials to Congress which requested support for the Fox-Wisconsin, Rock River, and Green Bay harbor improvements (Wisconsin, State of [Laws] 1848- [1863: 488-89; 1864: 548-49; 1865: 696-97; 1866: 205; 1867: 203, 208-11; 1868: 231-33; 1869: 269, 272; 1870: 234-35; 1874: 790; 1875: 678-79; 1885: 506-509]; Wisconsin, State of [Journal of Proceedings] 1848- [1868: 26; 1869: 23-24; 1875: 281-88]). In this period of intense promotion, the Wisconsin governor sought and received support in the form of memorials from other states as remote from Wisconsin as Maine, Connecticut, and Rhode Island (Wisconsin Governor 1840-1914 [1863-68, file 2, box 10]; Larson 1979: 171).

Cities along the Mississippi and Great Lakes began holding conventions to press for river improvements by the 1850s. Wisconsin delegates frequently attended. Waterway improvement conventions occurred at Chicago in 1863 and at Des Moines in 1864. They lobbied for federal support of multiple waterway improvements connecting Lake Michigan with the Mississippi. The February 1866, convention at Dubuque, Iowa, included rivermen, businessmen, and politicians from nearby states including Wisconsin. They pressed for improvement not only of the Rock River and Des Moines Rapids in the Mississippi but also stated a preference for the Fox-Wisconsin project as opposed to the Illinois River route (Tweet 1984: 64-66; Larson 1979: 168-69; Wisconsin, State of [Laws] 1848- [1864: 548-49]). The convention at Prairie du Chien in November 1868 was convened jointly by the governors of the states of Wisconsin, Minnesota, Iowa, and Missouri. It lobbied for improvements along the Fox-Wisconsin Waterway as well as the upper Mississippi and particularly the Wisconsin River from its mouth to Portage. It continued to compare the financial success of the Erie Canal with the possibilities for the Fox-Wisconsin (Fairchild 1869). Dealing with the same issues, the convention reassembled at Portage in October 1869. An 1868

⁶ All but one of these paintings are currently held in the collections of the State Historical Society of Wisconsin. For images of the paintings, see collection 2529 and WHi X313 and X32 in the Visual Images Collection.

convention at Oshkosh forwarded the memorials of the common councils of six cities along the Fox River to Congress (Fairchild 1869; Mermin 1968: 228; Wisconsin Governor 1840-1914 [1869-70]).

Even after the Army Corps assumed responsibility for the waterway in 1872, promotion of the project continued. Timely completion, a commodious channel, and improvement of the Wisconsin River remained important issues. Between 1872 and the mid-1880s, support of the improvement came from Wisconsin's governors, the legislature, congressional committees, private groups, and conventions. The convention at Oshkosh in June 1874 again included representatives from municipalities along the Fox. This convention pressed for its completion to the greatest capacity possible in three years (U.S. ACE [Report] 1839-1963 [serial] 1636, H. Doc. 1, part 2, 1875: 162; Mermin 1968: 107-11). The convention appointed a River Improvement Committee to examine the waterway, memorialize Congress, and continue to press Congress for the earliest possible completion of the waterway (Mermin 1968: 144-45).

Like many states, the State of Wisconsin and its citizens lacked the resources to complete the construction of the Fox-Wisconsin Waterway. The Wisconsin constitution expressly forbade the acquisition of state debt through support of internal improvements. Early promotional efforts to gain federal favor for its project brought a land grant and later additions. Attempts by three different agencies to utilize this resource ended with an incomplete project. The financial resources of the newly settled state proved insufficient to support project completion during the period when its communities most required waterway connections prior to the completion of the railroad network. Twenty years later Wisconsin turned once again to the federal government. This time it sought and received both federal oversight of construction and operation of the waterway.

THE ROLE OF THE ARMY CORPS OF ENGINEERS IN LOCAL NAVIGATION AND FLOOD CONTROL

The Creation of the Army Corps of Engineers and its Role in Navigation

Even during the ante-bellum period when the federal government largely left the development of internal improvements to the states, it did offer limited funding and land grants and provided some technical assistance for navigation projects through the Army Corps of Engineers. While the Army Corps thus eventually established its role in navigation, it did not specifically contribute to flood control or other areas of water policy until the second decade of the twentieth century (Merritt 1984: 39).

During the late eighteenth and early nineteenth centuries, the quality of the execution of large civil works, particularly transportation improvement projects, suffered from a shortage of civil engineers. Development of the nation's natural resources, agriculture, and industry required transportation improvements to move the raw materials and market the products. These needs prompted the Gallatin and Calhoun reports and the General Survey Act of 1824. Calhoun in 1819 had assumed that his plan would be completed under the Army Corps. The use of Army Corps

officers for nonmilitary, nationally important projects readied their skills for use during wartime. This need to prepare army officers for war as well as to move men and supplies during wartime became standard justifications for the completion of transportation projects through funding authorized by Congress.

Military engineers served in the army prior to the founding of the Army Corps of Engineers in 1802. The Continental Congress formally established a Corps of Engineers in 1779 and disbanded it after their immediate need ended in 1783. In 1794, Congress's concern for the intentions of European powers resulted in the hiring of French engineers and creation of a Corps of Artillerists and Engineers to develop necessary coastal defenses. It permanently established the Army Corps of Engineers in 1802 and stationed it at West Point, New York. Congress also created a military academy at West Point to train candidates in engineering, giving the Army Corps responsibility for its program. Prior to 1812, the Army Corps focused its energies on the two roles mandated by Congress, the military academy and development of coastal defenses. The improvement of the enlarged academy in 1817 was patterned after the French Ecole Polytechnique, the foremost school of engineering of the period. As late as 1824, the Military Academy served as the only school of technology and engineering in the United States. The academy provided the expertise necessary to the planning and construction of internal improvements and national defenses (Merritt 1979: 27; Tweet 1984: 34-35; Hill 1957: 3-5, 11-17, 21, 24-25, 27).

The Army Corps played a major role in the planning of the nation's military and civil works. In 1816, the War Department created a Board of Engineers for Fortifications to locate and systematically plan fortifications. The board recognized the need to establish interior transportation to permit the movement of men and the expansion of trade which was necessary to supply the army. The civil works under the stewardship of the Army Corps included those affecting regional and national water resources over which Congress alone possessed authority to fund and, except for the 1824 to 1838 period, to create policy. Congress appointed topographical engineers to the Army Corps in 1813. Although this segment was quickly disbanded, the topographical engineers were reappointed to the Army Corps in 1816. At this time, they operated under the Board of Engineers for Fortifications to conduct surveys for the coastal defenses. In 1818, Secretary of War Calhoun created the Bureau of Topographical Engineers within the Department of Engineers and under the direction of the same board. The exploration and mapping of the West became a major task assigned to this bureau.

To provide a greater number of officers to meet the increasing number of civil works projects, Congress removed this bureau from the Army Corps in 1838 and established a separate Corps of Topographical Engineers. This separation coincided with the repeal of the General Survey Act which returned to Congress the power to authorize surveys of canals and roads. The Topographical Engineers completed the civil works projects while the Engineering Department undertook military projects. This separate designation was intended to prevent the temporary assignment of army officers to civil works projects and provide a more coordinated oversight of these projects. Captain T.J. Cram who conducted 1838 surveys along the Fox and Rock rivers was a member of the Topographical

Engineers. In 1863, the Corps of Topographical Engineers were again absorbed into the Engineering Department (Merritt 1979: 27; Tweet 1984: 36-37; Larson 1979: 38-39, 48-49, 96; Hill 1957: 6, 8-9, 27, 92-93).

The 1802 project repairing and erecting public piers in the Delaware River was among the first civil works projects for which Congress authorized funding for completion by the Army Corps. This legislation set a precedent for project initiation by congressional act including the planning and construction under separate authorizations. Each authorization required the specification of funding level. Congress could appropriate funds to plan and construct projects which were national in scope, however it did not have the power to control the operation of the facility once it was completed. This function remained within the scope of state or local governments. But, for the next sixty years, the federal government's role in public works remained poorly defined. As noted, the constitutional question concerning federal or state jurisdiction over civil works severely limited the number of such projects authorized for completion by Congress prior to 1824. And, after 1824 until the Civil War, the distinction between what constituted a national or regional and local transportation route remained unresolved. Depending on the party in control, funding for civil works projects remained limited or nonexistent.

The 1824 decision in the case of Gibbon versus Ogden which confirmed Congress's jurisdiction over interstate commerce stimulated a large number of requests for improvements for steamboat navigation. The General Survey Act was intended to select projects of national-level significance for military and commercial needs along the routes of canals and roads. The act also specified the completion of the surveys by two or more civil engineers and officer of the Army Corps. Under the 1824 act, the president rather than Congress possessed the authority to select the projects. The president gave oversight of the program to the Board of Engineers for internal Improvements which remained in existence between 1824 and 1831. During this period, the president designated over 100 canal, road, and some early railroad projects for survey, and forty received approval for completion. Canals dominated the initial survey work (Merritt 1979: 43; Larson 1979: 15-16; Chorpeneing 1953: 986-88; Hill 1957: 45-49, 57, 59-60; 79).

The General Survey Act of 1824 specified canal but never included river and harbor or railroad improvements. Congress first appropriated limited funds for river and harbor improvements by ca. 1822. These projects included improvement of the navigability of rivers, bays, and harbors primarily by removing or circumventing obstructions such as snags, sand bars, and rapids; deepening channels and harbors; and building public piers, lighthouses, and other navigational aids. The successful use of the steamboat in the 1820s began to require comparatively large channels for navigation. Before the early 1820s, river and harbor improvements were not considered to be technologically difficult and did not require the engineering skills of the Army Corps. Local and state governments therefore constructed most of them prior to this date, and Congress had passed legislation permitting the levying of duties to support these improvements. The Treasury Department had also completed surveys of harbors and coastal waters and constructed structures to enhance the safety of navigation.

After the 1824 act to improve the Ohio and Mississippi rivers, Congress considered funding for rivers and harbors on an annual basis. The act specifically involved the federal government in these improvements and charged the Army Corps with this responsibility. While local and state agencies continued to engage in these projects, the Army Corps became the only federal agency to complete such improvements after 1824. The agency had offered sporadic engineering assistance in this area and began to examine the interior rivers by 1816. Major Stephen Long conducted an initial reconnaissance of the Mississippi and Ohio rivers and Lake Michigan between 1817 and 1823. He described these rivers, estimated their importance in trade, and indicated where the addition of canals would facilitate navigation. Prior to 1838 when the Corps of Topographical Engineers were specifically assigned to civil works, they conducted the river and harbor surveys while the Department of Engineering oversaw the improvements. Local civilian personnel often directed the construction work.

Funding for both rivers and harbors in one appropriation began in 1826. The General Survey Act enabled the Army Corps to complete general surveys for canals and roads without further congressional acts. However, the separate river and harbor appropriations specified each project receiving survey. River and harbor funding possessed two sections: one authorized preliminary investigations and surveys of specific locations and the second authorized and funded the construction of specific improvements. Prior to and increasingly after the Civil War, competition between cities and larger regions for funding became severe. River and harbor appropriations grew rapidly until the mid-1830s. Since Congress never developed an overall plan for improvement, it tended to fund small amounts to a wide array of projects so that the completion of one project occurred over a long period. After 1838 and the repeal of the General Survey Act, funding declined significantly for the next two decades.

Between 1826 and the repeal of the General Survey Act in 1838, Congress authorized over \$9 million for public works, taxing the small number Corps officers who supervised each project. The number of authorized projects declined earlier than 1838 as the Jackson Administration required that only national level projects receive consideration. Between 1838 and 1852, Congress only sporadically appropriated funds for rivers and harbors. The constitutional question remained an issue, sectional rivalry and executive and congressional rivalry for authority thwarted action, no unified plan for federal public works existed, and the Democratic Party which remained dominant during the period insisted that states retained the right to develop improvements. Congress did fund occasional surveys and a limited number of improvements along the Mississippi and Ohio rivers and along the Great Lakes after 1841.

When the Whig Party gained a majority in 1852, Congress appropriated \$2 million for river and harbors under the Western Rivers Improvement Act. This act again brought river and harbors improvements squarely under the direction of the Engineering Department and Topographical Engineers. Because the appropriations did not include monies for defensive works, the War Department assigned the Topographic Bureau to improvements along the western rivers and Great Lakes and the Engineering Department to the Atlantic and Gulf coasts. An apparently temporary Board of Rivers and Harbors was created for each corps to supervise

preparation of plans and estimates and inspect projects. The act provided funding for improvement of the Des Moines and Rock Island rapids, Dubuque harbor, and Illinois River, part of the Illinois and Michigan Canal project. Funds for these improvements were exhausted by 1855, and many of the projects remained incomplete (Merritt 1979: 44-45; Tweet 1984: 37, 52; Larson 1979: 71-72; Armstrong 1976: 31; Chorpene 1953: 988, 1000; Hill 1957: 154-71, 176-77, 181, 186-92, 216).

After the mid-1850s, the Republican-controlled Congress asserted its power over a weak executive branch and again began making annual appropriations for river and harbors improvements. The party clearly stated its intent to fund internal improvements to accommodate the needs of commerce in its 1856 platform. Contemporary interpretation of the Commerce Clause of the Constitution, similar to its interpretation in *Ogden versus Gibbons*, permitted Congress to affect navigable waters. Between the mid-1850s and 1950, approximately 90 percent of the appropriations for construction projects by the Army Corps involved navigation projects. Congress did gradually broaden the definition of what constituted navigation. For example, in the late 1880s and early 1890s, the Army Corps regulated structures which created obstructions to navigation such as bridges, pipes, and roads extending over navigable waters. It was given the authority to create regulations governing the use of navigable waters in 1890. By 1899, Congress provided direct permission to the Corps to build dams, levees, piers, and similar terminal facilities which assisted navigation. The agency had been constructing wing dams to deepen channels and levees to protect navigational structures along the Wisconsin and Mississippi well before this period. However, until after 1900, the justification for funding of Corps projects remained the improvement of navigation as directed by the Constitution (Merritt 1979: 446-47; Tweet 1984: 63, 135; Larson 1979: 95, 99).

The Structure of the Army Corps of Engineers

The Army Corps of Engineers evolved a structure which permitted its decentralized operation for participation in local projects and response to the specific circumstances of a region. This organization enhanced its ability to relate to local and state governments and interest groups. Placed under the Secretary of War, or later the Secretary of the Army, the Chief of Engineers executed the directives from Congress which authorized specific projects and policies. He orchestrated changes, modifications, and cessation of projects. However, this office made few decisions regarding the actual execution of projects. Extant by 1902, the Board of Engineers for Rivers and Harbors which included seven officers of the Army Corps reviewed all preliminary investigation and survey reports for the Chief of Engineers. This board was preceded by the Board of Engineers for Fortifications established in 1816, the Board of Engineers for Internal Improvements which remained in existence between 1824 and 1831, and a temporary Board of River and Harbors created in 1852. The actual oversight of projects was delegated to the field offices.

The decentralized organization of the field offices provided considerable autonomy to the divisions which were subdivided into districts. This structure

was formalized in the late nineteenth century. The area supervised by the division and district generally encompassed complete watersheds and their subdivisions. Suboffices were located at points of substantial construction and/or operation activity within a district. It was at the district or local level with review by the division office that the primary investigation, detailed survey, the preparation of necessary reports for these studies, construction, and operation of the improvements occurred. Each district was then permitted some latitude in shaping its own approach to individual projects whose circumstances were affected by the physical environment and social setting of a specific watershed. The district engineers came in direct contact with the needs and concerns of private corporations, special interest groups, and local, state, and other federal agencies. These local entities had often worked to procure the improvements and were affected by the public works once they were built. However, the decentralized authority structure to some degree removed the district engineer who was responsible to the division engineer from the pressure of opposing groups.

Several special organizations oversaw some of specific river and harbor projects. For example, the Mississippi River Commission which was created in 1879 supervised navigation and flood control projects along the Mississippi River. The seven member commission was composed of Corps officers who were not in active duty. It conducted its business through division and district offices (Merritt 1979: 38-40, 52; Maass 1951: 22; Tweet 1984: 11).

The Army Corps as a whole chronically suffered from a shortage of civil engineers and gradually gained more staff through the nineteenth century. The military personnel of a district were in charge of its management and responsible for final project decisions. While this personnel often had expertise in some areas of engineering and associated fields, that knowledge was increasingly supplemented by local civilian consultants and their staff. The Army Corps used civilian personnel on a project basis since at least the late 1830s. As the number of projects supervised by the Army Corps increased without a commensurate rise in the number of military personnel, the civilian staff assumed many administrative and engineering tasks in the twentieth century. By 1910, Congress formally permitted the inclusion of civilian engineers if a sufficient number of engineers were not available from the West Point Academy (Merritt 1979: 40, 52-55; Tweet 1984: 6; Maass 1951: 22; Moreel 1972 [1956]: 64; Hill 1957: 177).

Although the Army Corps was placed in the executive branch of the government, it tended to work most closely with Congress. Congressional legislation established the tasks which the Army Corps fulfilled. Local constituents and organizations initiated improvement projects through their representative who presented the resolution for funding in the river and harbor bill or as separate legislation. Army Corps involvement in the project occurred in three basic steps. A preliminary investigation studied the economic feasibility of the project. Because they were limited in scope, Congress authorized these examinations and detailed studies in a lump sum appropriation. If previous studies had been concluded, the House Public Works Committee often requested its review by the Office of the Chief of Engineers to determine if modifications of the project required a second preliminary examination. Preliminary and subsequent studies

occurred at the district level with review and comment by the division engineer. The Board of Engineers for Rivers and Harbors also reviewed these reports and made recommendations to the Chief of Engineers who made the final determination for continuing study.

The second, detailed survey including an economic and engineering feasibility study determined the most appropriate alternative for which were created plans and an estimate of cost. Originally, this study focused on the project itself. By the 1920s, the effect of the project on the river basin from the perspective of navigation. Hydroelectric power, flood control, and other issues were gradually incorporated into the study. The resulting reports were reviewed as in the first stage by the division engineer, the Board of Rivers and Harbors, and the Chief of Engineers who made the final recommendations for the project to Congress. The Secretary of War submitted the recommendations to the appropriate subcommittees and committees of Congress. Implementation of the project by the Army Corps required this final congressional review and insertion of funding into a river and harbor act. Congress did provide funding to the Chief of Engineers to complete recurring works of waterway improvement to reduce the number of authorizations. Following authorization, the district office of the Army Corps prepared detailed plans and specifications. For most construction projects, it then contracted with private firms recruited through a competitive bidding process.

Although the Army Corps carried out the congressional mandate, its project recommendations frequently did not coincide with the views of Congress. Most of the projects, in fact, had local and state significance rather than a regional or national scope. The agency, therefore, remained unable to establish national policies for its projects (Merritt 1979: 27, 40-41; Chorpening 1953: 1003-1010; Hill 1957: 67, 72, 74-76, 95; Maass 1951: 23-33).

Clearly defined Army Corps district and divisions did not emerge until the late nineteenth century. Originally, the same officer was not responsible for all the projects in a specific region, and districts with specific boundaries did not exist. Army Corps field officers were usually assigned to specific projects which were concentrated within a particular region. But, several Army Corps officers might work on different projects within the same region. However, the 1838 act creating the Corps of Topographical Engineers did permit it to establish regional offices at locations where it was undertaking several projects simultaneously. The initial geographic division of the country occurred in 1884 when four geographic areas supervised by division officers were defined for river and harbor projects. Located at the juncture of two watersheds, the Fox-Wisconsin Waterway has frequently fallen into two Army Corps subdivisions at Portage. As the number of projects increased in a region, the districts tended to be subdivided to permit closer supervision. The entire waterway was probably included in the western rivers geographic area of 1884. In 1888-89, five divisions incorporating forty-six project officers existed. The Northwest Division included the St. Paul area, and the Great Lakes Division incorporated a separate region. Exactly how the Fox-Wisconsin divided between these two districts is unclear.

In 1893, districts were defined, and these districts received specific names in 1908. The geographical areas included in districts and divisions as well as their names altered frequently. In 1908, nine divisions incorporated fifty-three districts. At that date, the St. Paul District was placed in the Northwest Division, the Fox-Wisconsin waterway occurred in the Milwaukee District of the Great Lakes Division (figure 5). The boundary line dividing the responsibility for the Mississippi between the St. Paul District and Rock Island District to the south fluctuated considerably in the late nineteenth and early twentieth centuries. The Army Corps combined the two offices between 1873 and 1886 and intermittently between 1911 and 1926. Prior to 1919 during the periods that the St. Paul District functioned as a separate entity, its area of jurisdiction remained north of the mouth of the Wisconsin River. After 1919, this area stretched to or south of the mouth of this river. By 1915, the St. Paul District was placed in the Upper Mississippi Division. By 1930, the Mississippi Valley Division included the St. Paul District while the Great Lakes Division which was headquartered in Chicago included the Milwaukee District. The Milwaukee District remained in this division through 1952. The Milwaukee District was absorbed by the Chicago District in 1955. Since 1955, the St. Paul and Chicago Districts have existed in the North Central Division which was first headquartered in Chicago and then in Detroit by about 1981 or 1982 (Merritt 1979: 56-57, 60; Tweet 1984: 6, 12-13; U.S. Army Corps of Engineers 1940-53 [1951-52, file 8D0.424; Zinn 1915; Running 1997; Peterson 1998; WDNR, Facilities and Lands 1951-87 [1951-60, memo for 6/29/54]]).

Prior to 1893, offices oversaw specific projects generally located in the same region. General Gouverneur K. Warren arrived at the St. Paul office in 1866 and remained there until 1870. The investigation of the upper Mississippi to establish shipping channels became an early task of this office. Warren supervised surveys along the Mississippi River from its source to Rock Island and surveys along the Minnesota, Wisconsin, and Fox rivers. Major Charles R. Suter completed the survey of the Fox and Wisconsin rivers under Warren in 1866. Warren continued to supervise the removal of snags from and dredging of the Wisconsin River from his St. Paul office through 1869. In July 1872, Major Douglas C. Houston who was responsible for the survey of the Fox River improvements was stationed in Chicago, Illinois. Improvement of the Fox-Wisconsin remained suspended until the government purchased the waterway in October 1872. Probably by December 1872, a local office was established at Appleton, and the Milwaukee office opened on a permanent basis sometime in 1872. Between 1872 and 1875, suboffices existed at Oshkosh, Appleton, and Madison. The Wisconsin River project was transferred from the St. Paul to Milwaukee office in 1872. The Wisconsin River system was returned to the St. Paul District in 1919 and remained in that district.

The Army Corps office at Chicago existed as a regional office for the Corps of Topographical Engineers in 1839 and sporadically thereafter. From this office, the Corps undertook the Chicago harbor improvements, and it served as a base for improvements in the western Great Lakes region. This office was then under the direction of Captain T.J. Cram. Cram located at Racine when he supervised harbor work along the west shore of Lake Michigan and the survey of roads in the Territory of Wisconsin. Officers in charge of harbor works along the west side

of the lake also frequently established their offices at Milwaukee. A permanent Army Corps office remained at Chicago after 1870 and a parallel office continued at Milwaukee. By 1916, responsibilities for the Lake Michigan harbors were divided between Milwaukee, Chicago, and the Grand Rapids districts (Merritt 1979: 38, 42, 58-60; Tweet 1984: 105, 252; Larson 1979: 38-39, 167, 170, 263; U.S. ACE [Report] 1839-1963 [serial 1413, H. Doc. 1, pt. 2, 1869: 187, 203; serial 1325, H. Doc. 1, 1867: 35, 259-63; serial 1598, H. Doc. 1, pt. 2, 1873: 220-47; serial 1675, H. Doc. 1, pt. 2, 1875: 216-226; serial 1744, H. Doc. 1, pt. 2, 1776: 194]).

CHALLENGES TO THE USE OF WATERWAYS FOR NAVIGATION

Waterway and Early Railroad Competition

Despite the growing support of the Army Corps of Engineers beginning in the 1850s, the transportation of goods by waterway in the Upper Midwest rapidly peaked and stabilized in the 1850s and 1860s and declined as the railroads expanded their networks in the post-Civil War era. After their use severely declined late in the nineteenth century, substantial support from the federal government rejuvenated the navigation of some of the waterways in the 1920s and later.

Between the 1830s and the 1860s, the West underwent rapid growth producing sufficient commerce to fill the available channels of trade. The direction of trade from the upper Mississippi Valley to the East Coast shifted from the long journey down river to the newly developed eastern water routes by the end of this period. Those routes which funneled the growing trade from the Upper Mississippi to the Great Lakes were considered to be of extreme importance. This alteration was reflected in the rapid growth of tonnage received at the Port of Buffalo from the lakes region and Ohio Valley. Whereas, shipments down river to New Orleans stabilized and fell. This shift was accelerated and completed by the Civil War blockade of the lower Mississippi. However, trade through New Orleans from the lower Mississippi Valley did remain significant.

East-west water routes to the Upper Midwest developing between 1830 and the 1850s included the two Ohio canals which were completed in 1838 and 1845 to serve the rich Ohio Valley; the Wabash and Erie which opened between 1849 and 1853 and proved significant for the trade of northern Indiana; and the Illinois and Michigan Canal which was finished in 1848 and served the Illinois and adjacent Mississippi valleys. Opening comparatively late, the Fox-Wisconsin Waterway began to carry traffic in the mid-1850s (Taylor 1951: 160-64).

The railroad was initially developed during the height of canal development in the 1830s. The locomotive was available in England by the opening of the Stockton and Darlington line in 1825 but remained untested along the more rugged and expansive American landscape. First operated in the United States in 1830, the locomotive as well as the associated tracks of the 1830s required repeated reconstruction as its components were improved. Significant railroad construction in the Upper Midwest had not occurred prior to 1847. Extant lines

were short and often connected trade centers with a sparsely populated hinterland and perhaps additional small trade centers. Some of the early midwestern roads in Ohio, Indiana, and Illinois connected with an improved waterway. Construction from the Ohio Valley to the Great Lakes expanded after 1848 and a line reached Chicago from Toledo in 1852. Intensive building from a large trade center such as Cleveland, Indianapolis, and Chicago to its hinterlands continued in the early 1850s. This approach resulted in a series of short lines. The consolidation of lines in Pennsylvania, Ohio, and Indiana, which produced the Pittsburgh, Ft. Wayne, and Chicago Railroad, created a single railroad system from Pittsburgh to Chicago in 1858. However, because such lines in the 1850s represented a combination of short, locally owned concerns, line changes even along connected trackage were frequent. The nonuniform track gauges required costly transshipment of goods between lines, and lines operated under different regulations and schedules. A line of uniform track gauges between New York and Chicago did not exist prior to 1860. The depression of the late 1850s delayed most railroad construction until 1863. The use of the railroad for military purposes during the Civil War emphasized its capacity for through transportation.

Railroad construction began in Wisconsin from Milwaukee by 1851. The La Crosse and Milwaukee crossed the Fox at Portage in late 1856 and reached the Mississippi River at La Crosse in 1858. A railroad connected Milwaukee with Fond du Lac at the south end of Lake Winnebago in 1859 and with Green Bay at the mouth of the Fox River in 1862. In the late 1860s, the railroads crossed the Mississippi, directly tapping wheat to the west. The railroad network became well established in Wisconsin by the late 1860s. Through the 1850s, settlement increased sufficiently rapidly in Wisconsin and adjacent states that the capacities of the newly introduced railroads and the waterways remained barely sufficient to carry the growing trade.

Until the Civil War, railroads in Wisconsin were generally seen as adjuncts to water transportation rather than competitors. In the 1840s, railroads had been designed to connect local points without the intention of creating an overall system for long-distance transportation. The 1853 annual report of the Wisconsin Board of Public Works (Green Bay and Mississippi Canal Company 1848-1909 [Wisconsin Board of Public Works 1853] [2]: 37) then directing work on the Fox Waterway observed the improvement's importance to the state, indicating that

...Connections are sought with this thoroughfare, by plank roads and railroads, projected and in progress of construction from different parts [sic] on Lake Winnebago, from Manitowoc to Chicago, to intersect it at different points from the mouth of the Wisconsin River to Green Bay. The formation of these various connections must and well [sic] add to the revenues of this improvement by assisting to develop the resources of these fertile and extensive valleys along its line, whose principle trade is to flow through its course.

The introduction of railroad eventually overcame many of the problems of waterway transportation: the seasonal use, slow speed, limited flexibility in location, and eventually the high cost of cargo transfer. However, waterway improvements

for steamboats had also represented a significant reduction in cost and far greater accessibility to markets than the previous reliance on wagons. It had been responsible for rapid expansion of interregional trade beginning in the 1820s. The effect of steamboat transportation on trade produced a comparatively greater impact than the railroad. Thus, the potential impact of the railroad was not necessarily obvious to the promoters of Wisconsin waterways in the 1850s and 1860s, especially during the developmental hiatus of the late 1850s and early 1860s (Taylor 1951: 85-86, 139, 164-67; Mermin 1968: 187; Tanner 1840 [1970]: 17-18, 21-22; Goodrich et al. 1961: 89-90, 111, 227-29, 249; Rubin 1961: 8, 44-45; Hoops n.d.: 19, 23; Paxson 1914: 247-66; Whitbeck 1915: 32; Drago 1972: 114; Conzen and Daniel 1990: 41).

Given the rapidly increasing volume of trade in the states of Wisconsin, Illinois, Minnesota, and Iowa in the 1850s and 1860s, contemporary view suggested that both modes of transportation would prosper. The railroads would carry goods to the Mississippi or Great Lakes for their transportation east and by extension they would convey goods to the Fox-Wisconsin Waterway and east. As through routes developed in the 1850s, the railroad gradually absorbed a growing proportion of the trade from the waterways. But, by 1860, the railroad did not exceed the waterways in the amount of total commerce carried. And, the waterways continued to transport most of the nation's goods by tonnage although not by value. While waterways continued to carry bulk products such as grain, lumber, coal, lead, and other raw materials, the railroads carried increasing amounts of the more valuable merchandise and livestock.

After the Civil War, railroad competition required carriers utilizing waterways to effect changes in their manner of operation for them to survive as a significant means of trade. Beginning in 1866, Congress funded improvements along the Upper Mississippi in response to the memorials from the nearly annual conventions of Mississippi River communities. The act supported surveys and the improvement of the Rock Island and Des Moines rapids and the upper river channel along the Mississippi River. These and later improvements were intended to reduce steamboat rates and maintain their competitiveness with growing east-west railroad trade. These improvements brought General Gouverneur K. Warren of the Army Corps to St. Paul in 1866 and were continued until 1907 when a revised plan established a new channel depth (Taylor 1951: 164-67; Mermin 1968: 184-85, 187; Tweet 1984: 66-67, 118; Hoops n.d.: 22-23; Wyatt 1986 [vol 2, sec. 2, transportation]: 2).

The railroad absorbed trade from the waterways which in some cases resulted in their decline by the 1850s and their closure in that decade but more frequently in the 1860s or later. By the mid-1870s, railroads transported two-thirds of the nation's east-bound grain crop. A contemporary study, the report of the Windom Select Committee of 1874, examined water routes in thirty-four states including the Fox-Wisconsin Waterway. It concluded that while railroad transportation to eastern markets provided a considerably shorter route, the average per ton rate was substantially less by the Fox-Wisconsin. Arguments that waterways provided less expensive modes of transportation for the carriage of bulk goods were offered as justification for continued improvement of the Fox-Wisconsin as well as other midwestern routes in this and subsequent reports through the 1880s. The

support of a railroad competitor such as the waterway was necessary to profitably market midwestern agricultural products and unfinished or partially finished raw materials. That waterways merely provided potential competition even if actually little utilized provided sufficient reason to continue their improvement and maintenance.

By the late 1860s when railroads became established as an east-west carrier, railroad rates to waterways such as the Mississippi exceeded those from the waterways discouraging the use of the railroad as a feeder line. Additionally, rates were often reduced during peak operation of water routes. Railroad rates between smaller trade centers where competition with other forms of transportation was minimal remained high thus considerably reducing potential profits. In the 1860s and 1870s, long-haul rates were increased to major commercial centers. The brief downturns in the economy of the early 1870s and 1880s when these discriminatory rates remained high severely reduced farm income. The operation of northern waterways was seasonal. For example, the Fox-Wisconsin was closed to navigation during the winter months between late November and the end of March. This seasonal use did not affect agricultural shipments but did interfere significantly with the movement of industrial products from the area and manufactured good transported to wholesalers in the area. The railroad's ability to build side-tracks adjacent to an industrial complexes eliminated conveyance of goods to the water's edge, providing a flexibility unavailable through the waterway improvement.

Railroads which had been heavily subsidized by the government were not meeting their public responsibility to provide transportation at a reasonable cost. Aware of its role in railroad expansion, government response to rate discrimination finally came in the form of railroad rate regulation through the Interstate Commerce Act of 1887. The Windom Committee had identified improved waterways as the competitors of railroads and an effective means of reducing and stabilizing its rates. Congress also attempted to control the monopoly railroads had gained over the nation's transportation by funding an alternative beginning in the late 1870s. The river and harbor acts passed between 1866 and the 1880s, particularly in 1882 and 1884, funded improvements intended to rejuvenate some of the waterways to provide such competition. In the 1882 legislation, Congress additionally restated the concept that navigable waterways were to be free of user charges (Moreel 1972 [1956]: 23-28; Hoops n.d.: 21-22). In reality, rather than the improvement of waterways, competition between the different railroad lines which crossed the Midwest reduced freight rates for long hauls between major trade centers in the late nineteenth century. However, the combining of lines in this period and the widely fluctuating grain prices reduced the level of this competition (Vogel 1993: 59; Wisconsin Governor 1840-1914 [1871-79: file 3, box 10]; Merritt 1979: 258-59; Larson 1979: 168; Moreel 1972 [1956]: 33; Goodrich et al. 1961: 245-46; Hoops n.d. 21, 27; Rathbun Associates 1984 [II]: 7-8, 12). Thus, by extension, after the Army Corps purchased the Fox-Wisconsin Improvement in 1872, their efforts were intended to create a waterway competitive with local railroad lines.

As compared to the Fox-Wisconsin route, the other waterways between the Great Lakes and Mississippi connected large hinterlands to well-established lake ports,

for example Chicago, Cleveland, and Toledo. Green Bay lacked the volume of trade developed by Chicago as well as Milwaukee which early became the lake terminus of many of east-west roads and Wisconsin's early railroads. As a consequence, the storage and processing facilities, wheat merchants, and banking support were not sufficiently developed at Green Bay to attract the financial and commercial support necessary to develop a major waterway during the late 1840s, 1850s, and early 1860s. Thus, the absence of funding from the state, the source of revenue which had supported the improvement of many of the ante-bellum improvements, resulted in a waterway of diminished commercial importance in the 1850s and 1860s.

The state constitution forbade state financial support of internal improvements. The state did permit the acceptance and oversight of federal land grants. As a reaction to the difficulties experienced by its neighbors with waterway improvements in the late 1830s, the state attempted to ensure proper management of these lands. It required that a certain percentage of the improvement reach completion prior to the release of lands even when the construction was in the hands of a state board. The project failed to reach completion under the board primarily because of limited financial support. The limited means of local private investors to attract sufficient capital to complete the waterway after 1856 particularly after the onset of the depression of the late 1850s resulted in little additional improvement prior to the growth of railroad competition. The expansion of the railroad as a commercial carrier between the Midwest and eastern markets after the Civil War coupled with the decision to end the improvement of the Wisconsin River by the Army Corps of Engineers ensured the waterway's development as a local waterway in the 1880s (Taylor 1951: 160-64; Peine and Neurohr 1981: 7; Libby 1895: 302-06; Mermin 1968: 187-88; Tweet 1984: 106; Goodrich et al. 1961: 250; Hoops n.d.: 19-21).

Competition with the Railroads: Deep Channel Navigation

The improvements along the Mississippi River and the organizations which promoted them influenced water policy decisions along its tributaries including the Fox-Wisconsin Waterway. Traffic along most navigable waterways including these two waterways declined significantly by the end of the century. However, while the long-distance trade and number of lumber rafts fell along the Mississippi, the local traffic rose. Without adequate crews during World War I, the short-haul traffic also fell. After the war, this shipping was not immediately resumed until the mid-1920s.

In 1905, the railroad system lacked sufficient capacity to carry the bumper crop of that year. In addition, the decline in railroad rates ended after the depression of 1893 in the late 1890s as expanding harvests increased the demand for transportation services. The completion of the Panama Canal in this period also meant that the shipment of parallel goods from the west to the east coast was cheaper than shipment by railroad from the Midwest to the east coast. The Interstate Commerce Commission began to permit railroad rate increases in 1924. This action nearly doubled the railroad rate ceiling between St. Paul and St. Louis by 1925. These rising railroad rates placed the Midwest at a considerable

economic disadvantage during the agricultural depression of the 1920s.

These events stimulated support for channel improvements in the early twentieth century. Concern for the inability of the nation's transportation system to move its commodities led President Roosevelt to form the Inland Waterways Commission in 1907. Of particular importance was the shipping of bulk products, once principally carried by the nation's waterways. Contemporary arguments framed by such spokesmen as Senator Newlands of Nevada stated that once the railroad had captured this commerce, it failed to expand its carrying capacity to meet the current level of production. Newlands favored a balanced development of each portion of the transportation network enabling cargo to travel by the least expensive and most efficient route. Roosevelt also advocated the development of a waterway network capable of carrying the larger, contemporary vessels.

These events also led to the formation of the Lakes-to-Gulf Deep Waterway Association of St. Louis, the Upper Mississippi River Improvement Association, and other organizations supporting the rejuvenation of waterways in the early 1900s. The St. Louis group pressed for the planning of extensive waterway improvements along the Mississippi and Illinois rivers to facilitate navigation between the Great Lakes and Gulf. They lobbied for the authorization of a six foot channel between St. Louis and St. Paul which occurred in 1907. The previous project to achieve a four and a half foot depth was established in 1878. Because Congress did not immediately fund the project, the six-foot channel project was re-authorized in 1922. The depth of the low water channel governed the size of the boat loads. Large loads meant that the waterway could economically compete with railroads. Thus, such channel improvement was essential to the maintenance of the remaining shipping.

Through these and later arguments favoring modernization of the inland waterway system ran the notion that federal improvement of this system would provide competition with the railroad in the movement of bulk cargo. Multiple avenues of transportation would thus reduce freight rates and maintain service adequate to move the nation's goods. In some cases, waterway improvement was valued for such reduction in railroad rates even if little potential existed for significant growth of waterway utilization.

As increased transportation of goods for World War I congested the railroad systems in the Northeast and relocated railroad transportation equipment away from the Mississippi Valley, the railroad periodically became locally idle. To gain control over the increasing chaos in the transportation industry, the federal government took control of the railroad in 1917. The United States Railroad Administration operated the railroad lines until 1920. A committee formed under the Council of National Defense found little active commerce on the Mississippi. To resolve railroad congestion, it recommended that the government seize worthy vessels to form a single fleet. Congress appropriated funds to the Emergency Fleet Corporation, a federal agency, to oversee the construction of boats and barges. The first occasion of direct federal operation of navigation facilities, the federal barge fleet began operation on the lower Mississippi in 1918. Intended to facilitate shipping during wartime, the line operated at a considerable loss under the War Department. In 1920, Congress passed the

Transportation Act which returned transportation facilities to private ownership. Since the barge line was built by the government, the act continued its operation as the Inland and Coastwise Waterways Service under the Secretary of War. Congress provided annual appropriations to support the line.

Although water transportation in fact played a small role in commerce during the war, the Transportation Act committed Congress to the promotion of commercial navigation to provide transportation alternatives to the railroad. As part of its program to stimulate water transportation, Congress established the Inland Waterways Corporation in 1924 to assume supervision of the government-owned fleet, the Inland and Coastwise Waterways Service, and stimulate commercial shipping on the lower Mississippi River. Placed under the authority of the Secretary of War, the project's goal was to operate the fleet on a more business-like basis. Once the feasibility of such a venture was demonstrated, the line was to be sold to a private concern. After considerable promotion by Minnesota and St. Paul business interests, the corporation organized a similar line for the Upper Mississippi River and all improved tributaries. Established in 1925, the Upper Mississippi Barge Line Company of the Twin Cities provided the barges and towboats and leased these facilities to the Inland Waterways Corporation. Beginning in 1927, it operated the line between St. Louis and the Twin Cities. The fleet was sold to the Inland Waterways Corporation in 1928. Boat traffic gradually increased, and three terminals were completed in the late 1920s. By 1953 when private capital had sufficiently invested in navigation facilities to ensure continued utilization of the Mississippi, the government sold the Inland Waterways Corporation to a private concern (Tweet 1984: 10, 14, 184, 241-45, 256-57; Rathbun Associates 1984 [II]: 9; Hull 1967: 31-35; Armstrong 1976: 46-47; Hoops n.d.: 29-30, 37-39, 49-54; Chorpening 1953: 1000).

Part of Congress's program to promote cost-effective shipping included the improvement of key waterways for larger carriers in the mid-1920s. Major competing navigation improvements included the St. Lawrence River as a navigation link between the Atlantic and the Great Lakes, the Erie Canal, and the Illinois and Mississippi rivers. The Illinois River project provided for a nine-foot channel between the Great Lakes at Chicago and the Mississippi along Chicago's Sanitary Canal, which paralleled the Illinois and Michigan Canal, and the Illinois River. Although the Army Corps of Engineers had intermittently worked on the Mississippi's six-foot channel improvement authorized in 1907 and re-authorized in 1922, it was only partially successful in achieving a uniform channel depth to six feet. As traffic rose, special interest groups, particularly the Upper Mississippi Barge Line Company and the Minnesota congressional representatives, pressed for a nine-foot channel between St. Paul and St. Louis. The barge line now acted as a lobby for navigation interests. By the 1920s, the upper channel did not accommodate the larger barges of the lower Mississippi River. Shippers were forced to make a costly cargo transfer to small vessels at Cairo or St. Louis. The nine-foot depth would also open a through-channel to the recently improved Ohio River and the proposed improvements along the Illinois River.

To plan the nine-foot channel using a slack water system, Congress authorized a survey of the Mississippi River above the Missouri River in the 1927 River and

Harbor Act. Before the completion of the 1931 final survey report which elaborated the detrimental environmental effects of the Mississippi project, Congress authorized work on the channel in 1930. It also approved work on the Illinois River and a portion of the Erie Canal identified as the New York Barge Canal. Further lobbying produced funding for the Mississippi River project. Construction relied on funds from the Public Works Administration, a work relief program established in 1933 which soon included \$178.9 million for the river and harbor projects. Funding from this program for the nine-foot channel came in 1933 and totaled \$55 million in 1934 and 1935. The initial system reached completion in 1940 at a cost of \$164 million (Merritt 1984: 41, 53-57; Mermin 1968: 151-55; Hull 1967: 38-39; Hoops n.d.: 50-77).

Promotional efforts toward establishing a nine-foot barge channel on the Mississippi and Illinois rivers to connect with the Great Lakes stimulated local support for a similar project along the Fox-Wisconsin Waterway. Prepared as early as 1907, memorials by local groups representing the cities along the Fox including Portage urged a preliminary investigation of the rivers for this purpose. In 1922, the Army Corps suggested that railroad rate discrimination against the waterway had occurred along the lower Fox. The report recommended maintenance of the waterway and improvement of the lower Fox River to the project depth of six feet at all locations since commerce there had risen in recent years. By the early 1920s, O.J.G. Peters led commercial interests in local communities along the Fox in support of deep channel navigation. Peters wrote at least three memorials to Congress in 1926, 1930 and 1948. Much of his evidence for potential usage came from his own survey of businesses which primarily clustered in Portage.

The Rivers and Harbors Act of 1925 authorized examination of the Fox and Wisconsin rivers to ascertain the possibility of achieving a nine-foot channel depth. Unlike the 1922 report, reports by the Milwaukee District of the Army Corps of Engineers in 1925 and 1930 found a low level of commerce along the waterway. The district concluded that the waterway did not warrant expenditure on the scale necessary to achieve the nine-foot depth. All but one of the communities of any size along the river had received railroad connections. The manufacturers in them expressed little interest in utilizing an improved channel. The 1930 report stated that only a remote possibility existed for the construction of a navigable waterway, presumably the nine-foot channel, between the Great Lakes and the Mississippi. But, it recommended that the construction of dams along the Wisconsin River provide for such a project.

Despite these reports, the Portage Register Democrat noted that the Upper Mississippi Barge Line had agreed to work with the Standard Unit Navigation Company of St. Louis to operate a barge capable of operating in 4' of water on the route between Green Bay and Prairie du Chien. A barge terminal was to be established at Prairie du Chien. The Portage Deep Waterway Committee demonstrated to the barge line the existence of sufficient trade on the Fox to warrant the barge service. The ultimate goal of the Portage committee was to establish a channel of sufficient size to carry ships from the St. Lawrence Waterway to the Mississippi River, permitting the transportation of grain from the Twin Cities. Based in part on the same information, the Army Corps rebuilt

the Portage Lock as a substantial concrete structure between 1926 and 1928. It had structurally failed during a flood in 1926 (Mermin 1968: 152-53; U.S. ACE [Report] 1839-1963 [serial 8005, H. Doc. 146, 1922: 25, 43-44; serial 9254, H. Doc. 259, 1930: 1, 5, 40, 42; 1927, pt. 1: 1327]; Peters 1926a; 1926b; 1930; 1948; Portage Register Democrat 1926 [11/29: 1/1; 12/10: 1/7]; 1927 [1/11: 1/1-2; 1/21: 1/7, 4/1; 2/5: 1/1]).

Railroad competition did heavily affect the level of navigation along the Fox Waterway. However, the state's constitutional restrictions forbidding the accumulation of debt from the construction of internal improvements limited the project's scale and greatly extended the period within which the project reached completion. Although important to local commerce along the Upper Fox, scheduled shipping along the waterway was not well-established prior to significant railroad competition beginning in the 1870s. Railroad competition in the late nineteenth century, then, quickly diminished waterway traffic especially along Upper Fox. Efforts to reduce railroad rates and establish an alternative method of transporting bulk goods led to the movement favoring deep channel navigation beginning by the 1920s. This improvement never materialized. However, the new concrete Portage Lock most probably resulted from the promotion of this project. Although the reduction may not have actually occurred, navigation along the Fox continued in the twentieth century to provide competition to the railroads and reduce the railroad rates.

FLOOD CONTROL: A GRADUALLY EMERGING RESPONSIBILITY OF THE ARMY CORPS

The development of the Portage Levee after 1850 which is integrated with the Portage Lock illustrates the operation of local, state, and federal statutes and laws regulating flood control measures. Until the end of the Civil War, the Army Corps of Engineers justified its participation in navigation improvements by references to the need to facilitate military preparedness and commerce. After the Civil War when commerce had become an accepted reason for Army Corps involvement in these projects, the agency justified its limited activity in levee construction and other flood control measures by associating the project with navigation improvements. Flood control gradually gained validation as the basis for Army Corps involvement beginning with Theodore Roosevelt's administration and the formation of the Inland Waterways Commission in 1907. This gradual incorporation of new roles for the Army Corps essentially reflects a shift from the consideration of only navigation improvements within the confines of a single project area to examination of a broader water policy including such issues as the production of hydroelectric power, flood control, water storage for irrigation, soil erosion, and pollution along the watershed in which the project was located (Armstrong 1976: 31).

The flooding which periodically occurred along the Mississippi River was the first to receive national attention. Consequently, considerable federal flood control policy developed from successful strategies tested against the Mississippi River floods. Army Corps involvement in flood control under the rubric of navigation began relatively early along its floodplain. As more communities developed along its banks to gain access to transportation, the

devastation to buildings and other improvements caused by flooding rose proportionately (Armstrong 1976: 247-49; Schneider 1953: 1088).

Prior to the 1870s, the responsibility for protection and recovery from the Mississippi River floods remained at the local level. Levees protected the banks of the Mississippi at New Orleans while the area remained under French jurisdiction as early as 1727. Private land owners constructed and maintained their section of the levee, creating a piece-meal structure which proved ineffective against floods of any size. By 1803 when purchased by the American government, 100 miles of crudely-built levees lined the river upstream from New Orleans. From this period to the 1880s, the federal government held the position that while navigation improvements assisted the public as a whole, flood control measures only affected the lands which they protected. Therefore, such problems were the concern of the private landowner and remained outside federal and often state jurisdiction. Flood prevention measures developed by the states remained relatively primitive or non-existent. Mississippi passed early legislation in 1846 which attempted to spread the payment for levee construction among affected landowners at the rear of flood zones as well as among the riparian land owners. By 1856, Louisiana developed a levee district system which taxed land owners in the district to achieve this end.

As early as 1851, Congress employed Charles S. Ellet, a civil engineer, to perform a hydrographic study of the lower Mississippi. He concluded that the growing severity of flooding had been increased by the construction of the long, continuous levee system which had slowly emerged for more than a century. The structures acted to restrict the flow of the river. Without natural drainageways for flood waters, flooding was increased in severity. He advocated the federal planning of a comprehensive system of flood control structures balanced by drainageways to relieve the flood waters rather than piece-meal levee construction by relatively small districts (Armstrong 1976: 249, 253; Merritt 1979: 360-61). His insightful conclusions which examined the larger waterway were not enacted along the Mississippi or elsewhere until the twentieth century.

Following the severe floods of 1849 and 1850, Congress passed the second Swamp Land Act of 1850 which distributed large acreage of wetlands in the public domain to the associated states. Attempting to develop these unproductive lands, Congress directed the cooperating states to drain and sell the lands and use the proceeds to develop further flood control measures. Although the act generally failed to accomplish the drainage of lands or development of flood control, it did establish a precedent for federal activity in the area of flood control. It also transferred these lands to the states, counties, developing levee boards, and eventually to private owners (Armstrong 1976: 53-54; Schneider 1953: 1048).

The Civil War destroyed many of the Mississippi River levees and navigation improvements as well as the economy of the states along the southern portion of the river. After several severe floods which caused additional devastation along the lower river and much public outcry, Congress finally enacted legislation to investigate the extent of damage in 1874. A commission composed of Army Corps officers and private civil engineers recommended the construction of a double levee system from the head of the alluvial delta to the Gulf and adjacent

tributaries. These works were intended, first, to facilitate navigation and secondarily to act as flood control measures for the rich agricultural lands along the delta area. These recommendations did not receive additional federal action until 1879.

Again, in response to public pressure for assistance in the reconstruction of Mississippi River levees, that is for flood protection, the federal government formed the Mississippi River Commission in 1879. Seven members including three Army Corps officers appointed by the president composed the commission. This commission introduced the federal government to the issues of flood control. The commission was vaguely charged with the duty of deepening navigation channels and protecting the banks to prevent destruction of the channel by flooding. Again, the commission's activities were to further commerce rather than flood control. The legislation enabled the commission to investigate methods of flood control, make recommendations for flood control, and assist the organization of local levee districts, but it could not directly construct flood control structures.

As the commission began to direct local levee districts in the reconstruction of their levee system in accordance with the 1874 recommendations, the flood of 1882 destroyed the partially rebuilt levees. In 1882, Congress reorganized the Mississippi River Commission. It divided the river into four sections and placed each section under the supervision of an Army Corps officer responsible to the commission. The Army Corps then became responsible for the construction of the levees. The officers interpreted commission policy for their section of the river and estimated needed congressional appropriations to carry out this policy. Funding for the post-1882 projects came from the commission which provided one-third of the cost and the levee districts which furnished the remainder. The major roles of the commission came to include the establishment of the most effective approach to levee construction, the supervision of the inspection and maintenance of levees, the management of contracts for navigation and flood protection improvements, and the provision of assistance during flooding. The direction of this initial project by the commission permitted the development of improved levee construction techniques. Levees were set back from the river to provide space for the floodway. Clearance of topsoil and stump removal limited seepage through the levee. It set levee heights according to the most severe floods on record and established cross-sections of sufficient width to achieve lateral structural stability. After the flood of 1890, funding in the river and harbor act to repair levees and increase levee height was provided without the usual reference to navigation assistance. Flood control was gradually viewed as a public need which had a sufficiently broad effect to receive federal funding.

Often identified as an advocate of environmental issues, Theodore Roosevelt established the Inland Waterways Commission in 1907. Through the commission, he strove to broaden the single-purpose development of American waterways and coordinate the activities of the growing number of federal agencies affecting water policy. These agencies occurred primarily in the departments of Interior and Agriculture. He acknowledged that the Army Corps and other agencies had in the relatively recent past examined waterways from more than simply the perspective of navigation. They had considered, for example, power, irrigation, flood protection, and water supply. Rather than considering single uses of water

resources, the commission headed by Senator Newlands advanced the creation of a plan which considered and integrated the multiple uses of the each river basin in the nation. The commission recommended a water resource authority to be known as the National Waterway Commission and to be placed in the executive branch. Its role included the planning of water resource utilization and the coordination of the work of the agencies which affected water resources. Such agencies included the Army Corps, the Bureau of Soils, the National Forest Service, and the Reclamation Service. However, Congress failed to fund a permanent commission in the executive branch. Each federal agency and their congressional advocates preferred to maintain control over its specific mandate. Thus, the effect of the Inland Waterways Committee on the coordination of water policy was at least temporarily quite limited (Armstrong 1976: 32, 249; Merritt 1979: 361; Maass 1951: 65-67, 72; Schneider 1953: 1050-52; Moreel 1972 [1956]: 37, 65-66).

Following the devastating flood of 1917, the 1917 Flood Control Act provided monies to the Mississippi River Commission to construct and heighten levees. The portion of the appropriation involving the Mississippi River viewed flood control as a measure which could be funded with federal monies in its own right without resort to the inclusion of navigation improvements. The Army Corps was also to consider the effect of its projects on flood control. The act established specific ratios for federal and local funding. It directed the levee districts to provide the lands and rights-of-ways and maintain the structures after construction. However, because the act left much of the construction in the hands of local levee districts, the structures continued to be constructed in a piece-meal fashion. Congress continued to confine the activities of the Mississippi River Commission to the delta area and the immediate backwaters which contributed flood waters to this area (Armstrong 1976: 33-34, 254-55; Merritt 1979: 49, 360-62; Schneider 1953: 1056).

Stimulated by World War I, companies engaging in large scale industrial development which demanded large amounts and consistent flows of energy had begun to establish large, interconnected hydroelectric energy plants. Congress had directed the Army Corps to consider the effects of navigation improvements on hydroelectric power production by 1909. In 1920, it enacted the 1920 Federal Water Power Act which created the Federal Power Commission. The commission was to establish orderly waterway development which then principally included power production with navigation requirements. Following flooding in 1923, the River and Harbor Act of 1923 provided funding for the improvement of some of the nation's levees over a five year period. The River and Harbor Act of 1925 instructed the Secretary of War and the Federal Power Commission to estimate the cost of conducting surveys along the nation's navigable streams and their tributaries to determine this need. The investigations were to consider power production, flood control, and irrigation. Completed in 1926, House Document 308 provided this estimate of cost. The 1927 River and Harbor Act then ordered the Army Corps to conduct comprehensive surveys of 191 principle watersheds and produce reports addressing the issues listed in the 1925 act. Completed over the next decade by the Army Corps districts, the resulting "308" reports became the basis of multi-purpose watershed planning and, eventually, development (Armstrong 1976: 32, 249-50; Merritt 1979: 48; Schneider 1953: 1057).

The devastating 1927 Mississippi River flood produced the first comprehensive flood control legislation, the 1928 Flood Control Act or the Jadwin Plan. It authorized the Army Corps to develop a flood control plan encompassing the entire alluvial valley of the Mississippi River. In the act, Congress verified as sound principle local contributions toward the cost of flood control because it recognized the special interests the affected communities held in the project. However, given the large expenditures already spent by local entities, section two of the law did not require local contributions from communities along the Mississippi. Under sections three and four, they were to provide rights-of-way for the structures and maintain the works after they reached completion.

The plan produced by the 1927 act also became known as the Mississippi River and Tributaries Project. As part of the plan detailing protective measures, the Army Corps hypothesized the severest flood possible based on previous flood episodes. A version of this method was later generally adopted for flood control design along other rivers. The plan defined the necessary flood control measures, a combination of levees, floodways to carry excess flows, channel stabilization to increase flood-carrying capacities, and tributary basin improvements to reduce flood waters coming into the Mississippi. Although the plan recognized the need to control backwaters, it failed to consider the damage caused along tributary rivers and their contribution to flooding along the Mississippi. Section six authorized the completion of flood control work along the backwaters above Rock Island. However, here it required a local contribution of 33 percent of the cost. After 1936, additional flood control acts included measures to control flooding along tributary waterways which were discovered to contribute to the major portion of the flooding along the main stream of the Upper Mississippi (Armstrong 1976: 257-59; Schneider 1953: 1058; United States [Statutes] 1867-1958 [1928 [vol. 45, chap. 569]: 534-38).

The 308 reports reached completion near the end of the Depression Era between 1935 and 1938. These studies supplied information for the federally financed projects and federal work programs of the 1930s, for example the Works Progress Administration, the Public Works Administration, and the Civilian Conservation Corps. Under the Roosevelt Administration which recognized the need for a planned, coordinated, and balanced program of natural resource development, flood control and other water policy issues were then becoming more clearly recognized as federal concerns. Without success, Roosevelt attempted to set up commissions in the executive branch to plan and coordinate the multiple uses of water resources within drainage basins. This need was noted by his 1935 National Resources Board and later similar commissions. Their coordinating role was based on the supposition that since the interstate character of rivers had squarely placed the responsibility for navigable rivers within the federal domain, the federal government also, then, possessed jurisdiction over flood control along those rivers. Further, local efforts to control floods with levees and other structures affected the flow of the river downstream. Thus, as levee boards, cities, counties, railroads, and other groups constructed levees to protect their own property, they often endangered the property of others. Federal oversight of flood control to coordinate such measures could be viewed as a constitutional use of federal powers (Armstrong 1976: 250-51; Maass 1951: 74-75; Schneider 1953: 1059; Moreel 1972 [1956]: 69-70).

This awareness of the need for a coordinated program resulted in the passage of the General Flood Control Act of 1936. Initially, Congress simply intended to fund flood control measures approved by the Army Corps after the floods of 1936 with work relief appropriations. The law funded \$300 million for flood control studies producing detailed plans in thirty-one states and along 222 rivers. In addition, the act also established a national policy regarding flood control. In the "Declaration of Policy," the act stated that flood control was a federal responsibility (in Schneider 1953: 1060). It clearly placed flood control with drainage and channel improvement along navigable waters and their tributaries within the sphere of the federal government funding and regulation. The Supreme Court affirmed this legislation by a ruling in 1940 which stated that the commerce clause of the constitution provided authority to the federal government to participate in flood protection and watershed development. The 1936 act gave the Army Corps of Engineers responsibility for supervising flood control along navigable rivers and establishing procedures for surveys and studies. From the act, the Department of Agriculture received jurisdiction over water flow retardation and soil erosion prevention in small watersheds.

The 1936 act and its later modifications, then, gave the Army Corps an active role in major flood control projects. Congress directed the Army Corps districts to assist states, counties, towns, and municipalities as well as other federal agencies with the planning of flood control. With the assistance of private firms and input from these local entities, the Army Corps planned and designed flood control measures. The Army Corps received specific direction regarding public input in 1944. It also supervised the construction which was completed through contract with private firms. The 1936 act possessed several deficiencies one of which delayed considerable construction until after World War II. It required that communities which were already severely taxed by the burdens of the depression assume considerable financial responsibilities for their project. While recognizing flood control, the act generally ignored the close relationship between flood control and land use and other water uses. And, as Roosevelt pointed out, the activities of federal agencies relating to water resources remain uncoordinated. Despite the president's efforts to establish such a commission in the executive branch, the agencies' answer to coordination became the Tripartite Agreement of 1939. This agreement was to facilitate the free interchange of information between the water resource agencies including the Army Corps. The agreement produced limited cooperation and failed to achieve agreement in policy decisions (Armstrong 1976: 251; Merritt 1979: vii, 49, 56-57, 362-63; Chorpening 1952: 1004-05; Maass 1951: 84-86, 109-10; Schneider 1953: 1060-61).

Multi-purpose waterway development as part of a river basin plan generally occurred after World War II. The Flood Control Act of 1944, or the Pick-Sloan Plan, made limited strides in this direction. Replacing the earlier Tripartite Agreement, the federal agencies involved with waterway development established the Federal Inter-Agency River Basin Commission in 1943. This agency was to facilitate interagency cooperation for water resource planning. This approach became Congress's alternative to funding such an agency in the Bureau of the Budget in the executive branch as requested by the president in Executive Order 9384. Congress remained reluctant to share its role in water policy

determination.

Established by Harry Truman in 1950, the President's Water Resources Policy Commission prepared recommendations for the establishment of a comprehensive water policy. Additionally, Truman directed federal agencies affecting water resources to corroborate in water resource planning and to request input from the states. This directive resulted in the production of a substantial number of comprehensive river basin studies. Having similar functions, the Interagency Committee on Water Resources replaced Congress's Inter-Agency River Basin Commission in 1954. Composed of the heads of agencies dealing with water resources, the committee provided coordination for the activities of agencies in water and related land policies, resolved policy differences between the agencies, and assisted the president with necessary policy changes in current laws. Formed in response to these executive initiatives, the Senate Select Committee on National Water Resources or the Kerr Committee held hearings on water resource policy between 1959 and 1961. The conclusions of the legislative committee finally reflected the views of the executive committees, the need to develop comprehensive water resource plans for watersheds and floodplain management through the cooperation of federal agencies, states, local governments, private corporations, and concerned organizations. With its major role in water resource development, the Army Corps of Engineers played an active role in the evolution of this policy during this period between 1946 and 1961 (Armstrong 1976: 32; Merritt 1979: 49-51; Moreel 1972 [1956]: 72-74).

As increasing populations supported rapidly expanding capital improvements along the Mississippi, initially local governments became involved in flood protection. The early policies recognized that flood control required more coordination and funding than the individual land owner could provide. While the federal government did provide very limited funding for levee construction through the donation of overflow lands under the 1850 Swamp Land Act, it did little to support positive flood control measures until the creation of the Mississippi River Commission. Even here, justification for involvement was expressed in terms of navigation improvements. During the mid to late nineteenth century, state governments began to shoulder some of the responsibility for flood protection. Beginning with the Flood Control Act of 1917, Congress gradually recognized that flooding could be caused by the actions of multiple communities and states and protection required coordination by an entity larger than these levels of government. Congress guarded its role in flood protection closely, providing the executive branch with little ability to coordinate the different federal agencies which affected water policy. As the federal government became more involved in flood control policy, the Army Corps of Engineers gained increasing responsibilities in this area. The Flood Control Act of 1936 directed the Army Corps to cooperate with other governmental units to achieve the necessary measures. Although Senator Newlands advanced the concept of comprehensive river basin studies examining multiple issues of water policy in the first decade of the twentieth century, achievement of this goal did not occur until after World War II.

A REVIEW OF NINETEENTH AND EARLY TWENTIETH CENTURY LOCK TECHNOLOGY

The following summary of canal technology focuses specifically on techniques utilized in the construction of locks located along the Portage Canal with reference to other structures used along the Fox Waterway.

A slack water system such as the one constructed along the Fox River improved waterways with a steep gradient with or without rapids by establishing a series of dams each of which created a pool or area of level navigation behind it. A canal which usually contained the one or more locks provided access around the dam. The lock moved the boat between adjacent pools so that the waterway became a series of steps. The dams of the Lower Fox raised vessels along its steep gradient and over rapids. The dams of the Upper Fox were intended to provide a greater depth above the sand bars along the bottom rather than overcome significant gradients. The dam at Governor Bend created the pool to the Fort Winnebago Lock. The Fort Winnebago Lock at the west end of the Portage Canal did create a significant lift of about 6' to raise vessels from the Fox up to the level of the Wisconsin River. Navigation dams are not associated with the two locks at either end of the Portage Canal. When the Fox and Wisconsin rivers were perceived as a single waterway, then the Portage between the two rivers became the summit level (figure 4). Slack water systems with summit levels including the Erie Canal contained both ascending and descending levels rather movement in a single direction.

Finally, although many slack water systems were placed along existing waterways such as the Fox River, engineers of the early nineteenth century advised against this approach. More subject to flooding than canals and, depending on the base material, possessing bottoms of shifting sand, the channel of improved waterways tended to move in width and depth. Such improvements required relatively constant maintenance to provide a satisfactory channel. The Fox and Wisconsin rivers were no exception (Shank 1982: 37; Goodrich et al. 1961: 3, 24).

A common construction in the United States, the pound lock or lock with one or two gates at either end of the lock chamber was introduced in this country in the late 1700s. In continental Europe, the Dutch were among the first to develop this lock type by the late 1300s. In the same period, between 1391 and 1398, the Germans constructed an early summit level canal within the Stecknitz Navigation system. Constructed in 1485, the locks along the Bereguardo Canal in Milan, Italy, utilized a pound type lock with miter gates or horizontally swinging gates. Gates developed prior to this period moved vertically. By 1600, the pound lock with miter gates had become the most common form in continental Europe. A majority of the lock gates used in the United States except for early locks or those introduced after the first several decades of the twentieth century were miter gates. By the mid-1700s, miter gates were often closed with booms. Attached to the top of the gate and considerably overlapping its outside edge, the lever-like boom rested on a quoin post between the gates and the lock wall. Attached to the side walls, the gates thus pivoted open and closed (Stevenson 1838: 201).


After the departure of the Romans, the English failed to maintain and develop a

system of canals until the mid-seventeenth century. Constructed between 1759 and 1776, the Bridgewater Canal in northern England was constructed at the beginning of England's canal era. It transported coal between the mines at Worsley and Manchester. England's first canals contained the pound lock. These structures were initially relatively narrow, about 7' wide and only later did they reach 15' wide, the width used along the Erie Canal. Such narrow widths were usually associated with the operation of towboats propelled by animal power. The era of major canal construction ended in England in 1835 although canal mileage was added until about the 1850s. As noted, during the early decades of American canal development, few engineers were available to guide canal construction. Several European, primarily French and English, engineers filled the void.

The construction of short canals occurred in the United States in the 1780s, for example the Carondelet Canal from Spanish-controlled New Orleans completed in 1785. The Santee and Cooper Canal in South Carolina and the Middlesex Canal between Lowell and Boston, among the first canals of significant length, were constructed between 1793 and 1800 and 1794 and 1804 respectively. These canals with adjacent towpaths had pound locks most of which were closed with miter gates. These structures were used along many American canals in the first half of the nineteenth century (Shank 1982: 5-6, 15-18).

Although different materials might be used, many of the basic components of the lock altered little after 1840 until after the first several decades of the twentieth century. The lock chamber denoted the area inside the gates and side walls. Hung vertically, the two leaves of the two miter gates closed the ends of the lock. The socket attached to the outside, bottom corner of the gate pivoted on the pintel mounted in the lock floor. The upper or upstream gates, the shorter of the two pairs, sat on the breast wall which was level with the bottom elevation of the upstream end. Iron straps or collars inserted into the top of the lock wall held the top of the gate. Horizontal, square timbers secured with vertical beams typically composed nineteenth century gates such as those described for the Fox Waterway. Closed in a V-shaped position by the weight of the water, both pairs of gates opened in the same direction against the flow of the stream. The upper gates opened into a recess along the walls out of the lock chamber, and the downstream or lower gates opened into a recess in the chamber. The side walls on upstream end of the lock extended well beyond the gate, perhaps 30', to receive the upper gates and protect the adjacent bank. Both pairs of gates opened into a recesses in the lock walls. The gates closed against the V-shaped miter sill, a wooden or masonry triangle pointing upstream.

Located at the end of each gates against the wall, the wood quoin post or hollow quoin was semi-circular in cross-section. It stood with its rounded side against a groove along the side of the lock chamber and with its squared side against the edge of the gate. They were intended to limit leakage along the gates. Extending parallel with and outward from the top of the gate well outside the lock chamber, the balance beam pivoted on top of the quoin post. The landward weight of the beam counterbalanced the weight of the gates, making them easier to open. The first locks at either end of the Portage Canal opened with balance beams. Photograph WI-104-57 may show a balance beam at the Winnebago Lock. Later in the century, horizontal iron rods or gate spars ran from the top inner



corner of the gates to a tripod secured on the tripod platform on the lock wall. The platform occurred upstream of each gate. The gate spars were inserted into geared vertical shafts supported by the tripod. A removable bar was used to crank a socketed hub geared into the vertical shaft. When the gate was cranked open, the spar travel under the tripod platform. An adjustable rod or turnbuckle between the top of the lock wall behind the gate and the iron collar leveled the gates to make them more water tight. Leveling the gates was later completed with iron turnbuckles gate levelers which formed a V in the side wall behind the edge of the gate (photograph WI-104-30).

Near the base of the gates occurred a horizontal series of rectangular openings, most frequently maneuvered with butterfly valves (photograph WI-104-48). The iron or steel valve covers pivoted on a centered shaft. A rod which extended down from the top of the gate opened the valve door by a crank handle or lever at the upper end. The butterfly valves controlled the water coming into the lock chamber to flood or drain the lock. To open the gates, the water level in the lock chamber had to reach the level of the waterway. Used to secure the boat in the lock, wood or iron snubbing posts were aligned along each side wall. At Portage, locks typically had three posts along each wall (Stevenson 1838: 201; McFee 1963: 89-92, 101; Richards 1995: 10; Rathbun Associates 1984: II-7).

Many of the small, improved American waterways and locks constructed in the first half of the nineteenth century accommodated relatively narrow boats propelled by animal power along adjacent towpaths. Originally constructed with adjacent towpaths, the Erie Canal's lock chambers measured 15'-0" x 90'-0" prior to their enlargement. To remain financially viable, the lock sizes grew larger through time as the vessels they accommodated expanded in size and tonnage. For locks, the measurements which most limited the size of the vessel and hence the tonnage carried were the width and length. If it did not set on bedrock, the lock's depth was more easily adjusted. For river improvements, waterway depth became the ruling measurement especially when its attainment resulted in flooding along adjacent property. As the use of steamboats became more common, the width of both the channel and locks required enlargement. By 1862, most of the locks along the Fox Waterway which was intended to carry steamboats measured 35' wide and 140' to 165' long (Fox and Wisconsin Improvement Company 1859-62 [1862: 4]).

Steamboats occurred on Lake Winnebago by 1845 and began to operate along the portions of the Fox by the early 1850s (Vogel 1993: 41-43). Robert Fulton and John Stevens had initiated the use of steamboats along the Hudson in 1807. While the first steamboat ascended the Mississippi River to the site of St. Paul in 1823, fairly regular steamboat arrivals did not begin until 1847 (Merritt 1979: 28-29). Steamboat traffic on canals did not develop significantly until the 1850s or later (Vogel 1993: 15). Although the Fox Waterway was constructed for steamboats, at least the Portage Canal included a towpath after its initial construction until 1876 when the Army Corps widened the canal. Schultz reported that this towpath was used (Schultz 1941). Constructed much later, between 1892 and 1907, the Hennepin was also bordered by a towpath which remained unused (Swanson 1984: 46).

Completed by hand during the first two-thirds of the nineteenth century, the

digging of canals required a large crew and a long construction period. Work along the Erie Canal did begin to systematize the approach. New York State hired local private contractors with local crews to complete short sections of the canal. Sections often measured as little as one-fourth of a mile. The state's engineers developed a set of overall specifications which applied to each contract and added items applicable to a particular site. These guidelines indicated the manner of grubbing, clearing, and excavating at the site of the canal and specified the type of construction for the banks, towpaths, waste weirs, and locks. The records of the Wisconsin Board of Public Works which initiated construction along the Portage Canal in 1849 provided standard contracts specifying similar items. Its contracts were also modified to suit each job along the Fox Waterway (Wisconsin Board of Public Works 1850-53).

Implements used in mid-nineteenth excavation of canals included plow and horse-drawn dirt scrapers which replaced spade and wheelbarrow as the main method of removing earth, root cutting shovels, and stump pullers. Use of horse and scraper required three men one work season to complete one mile of canal. However, wet ground which characterized the site of the Portage Canal prohibited the use of these implements, necessitating excavation with spade and wheelbarrow in this situation. Puddling the bottom of the canal with different forms of naturally occurring muck prevented the escape of water from the Erie Canal. The Board of Public Works required puddling along the bottom of the Portage Canal when it was first under construction (Shank 1982: 19; McFee 1963: 56; Goodrich et al. 1961: 3; Chorpene 1953: 1000; Shaw 1966: 90-94; Wisconsin Board of Public Works 1850-53).

Dredging assisted the widening or deepening of existing channels. The Wisconsin Board of Public Works developed a dredge for use along the Fox Waterway in 1849 (Green Bay and Mississippi Canal Company 1848-1909 [Board of Public Works, vols. 1-2]). However, it was not used to assist the excavation of the Portage Canal in that period. The dredge's manner of construction was not detailed (Wisconsin Board of Public Works 1850-53). Early in 1868, G.K. Warren adapted the Montana and Caffrey, the first two steamboats owned by the Army Corps on the Upper Mississippi, for dredging operations along the Wisconsin and Mississippi. To the stern of the boats he attached a Long Scraper, a triangular, wooden device with the base facing downward. Half cylinder scrapers were placed along the base of the triangle. While the boat backed downstream, the lowered scraper plowed up the bottom, and the action of the churning wheels flushed the material downstream (Chorpene 1953: 1014; Tweet 1984: 117). As the century progressed, more advanced technology assisted excavation along the Fox Waterway. During the mid-1870s, the Army Corps of Engineers used a steam excavator, wheel barrows, and small construction cars during the enlargement of the Portage Canal. By the 1890s, steam-powered cranes facilitated moving earth at the Hennepin Canal. Steam operated derricks, cranes, and shovels towered over the construction site at the Portage Lock between 1926 and 1928 (Shank 1982: 46-48; Porter 1926-28).

Not only did the Erie Canal stimulate the initiate surge in American canal construction in the late 1820s, but its construction occasioned an additional significant technological developments in the building of canals and in building construction in general. In the early nineteenth century, although stone was the

preferred material for locks, its use presented several construction problems. Timber locks or composite locks with walls of dry-laid rubble stone placed in cribs and faced with several layers of planking could be made sufficiently water tight. The wood along the sides protected boats from damage. But, timber hydraulic structures deteriorated quickly and required a high level of maintenance. Because of the frequent inaccessibility of adequate building stone, high cost of the material's transportation and use in construction, and lack of a suitable hydraulic mortar, timber locks were more common than stone during first two-thirds of the nineteenth century (Stevenson 1838: 192-93). The source of stone rubble for the composite canal locks at Portage remains unclear. The 1881 annual report of the Army Corps indicated that the agency had opened a quarry adjacent to Duck Creek. Worked prior to 1879, the Army Corps secured both dressed stone and rubble from the quarry. In 1879, the stone was utilized in the works at Appleton (U.S. ACE [Report] 1839-1963 [serial 1955, H. Doc. 1, pt. 2, vol. 2, pt. 3, 1881: 1969]).

Stone hydraulic structures required the use of cements which hardened in water rather than lime mortar which dissolved in water. In 1817 when construction on the Erie Canal began, cement was only available in its natural form. The identified sources of reliable natural cement were in Europe, making its cost in large quantities prohibitively expensive. Although a natural form of cement was used extensively by the Romans, the sources and processes associated with it were lost during the Middle Ages. Cement is composed of quicklime or calcium oxide which is obtained through calcination or the burning of finely broken limestone. The Romans later discovered that when quicklime was mixed with volcanic earth, a material known as pozzolana, it set in water. By 121 B.C., the Romans had mixed this hydraulic lime with sand, water, and an aggregate of broken stone or bricks to form a hard substance which had many of the properties of stone.

By 1796, James Parker of England had located a naturally occurring shale-bearing limestone which when calcinated produced the desired product. Thomas Telford of England who had considerable experience in the construction of canals and other hydraulic structures tested Parker's cement or Roman cement for such purposes shortly after its patent was issued. He published a favorable report concerning its durability in the use of structures subjected to the exposure of water. All these efforts relied on a naturally occurring hydraulic cement. Its application to hydraulic structures occurred by 1850 in England. But, a reliable hydraulic cement which did not rely on natural occurrence still awaited development (Elliott 1992: 153-60; Condit 1968: 155-56).

When construction began on the Erie Canal in 1817, the stone locks were built with lime mortar which began to deteriorate as early as 1818. After returning from his 1817 investigation of hydraulic structures in England, Canvass White identified a deposit of clayey magnesian limestone near Chittenango, New York, and close to the route of the Erie Canal from which cement was obtained. This source represents one of the first deposits of naturally occurring cement identified in the United States. A deposit near Boston may have been located in 1797 by William Weston for the construction of the Middlesex Canal. Rather than constructing the locks with timber or stone and lime mortar pointed with hydraulic cement, White guided the building of comparatively permanent lock

structures composed of stone laid in hydraulic cement. But, while White pioneered the use of cement in the United States, patented his product in 1820 and 1821, and established a cement works at Chittenango by 1825, its use required the discovery of natural deposits of limestone which produced cement. Between 1820 and 1850, about a dozen deposits were located in Illinois and Kentucky. Because of the impurities often found in all limestones, the quality of the cement depended on the type of deposit used. Cement did become an important material in the construction of canals. However, if deposits were not located near a construction site, its transportation to the site often prohibited its use. Monolithic construction using concrete remained relatively rare until late in the nineteenth century (Elliott 1992: 160-61; Shank 1982: 18-19, 22; Goodrich et al. 1961: 65; Drago 1972: 12, 178; Shaw 1966: 94-96; Condit 1968: 157).

Cement mortar was used along the Portage Canal by the 1890s at both the Fort Winnebago and Portage locks to bond the stone rubble in the cribs and to finish off the top of the lock walls. This use of poured concrete occurred during a critical period in the development of concrete. J.S. White and Sons and Joseph Aspdin and Company, both of England, manufactured true Portland cement by 1848. But, the explanation of the properties of cement, its compressive strength, its curing process, and ability to retain its properties in water remained poorly understood. By the 1870s, it was discovered that oxides of aluminum and silicon formed essential properties of hydraulic lime, but a clear understanding of the chemical reaction which occurred during the setting of cement was not gained until the twentieth century. Rather, advances came in the improvement of its manufacture. It was not until the late 1880s and the development of the rotary kiln in England that a consistent and reliable product emerged. ★

Americans who tended to rely on naturally occurring cement were unwilling to invest capital in investigation of the properties or manufacturing of Portland cement when it could be imported at a relatively low cost from Europe as ship ballast. Located along Pennsylvania's Lehigh Valley, the Copley Cement Company first marketed Portland cement in the United States in 1871. In 1876, the company began the production of Anchor Brand Cement. The cement won the highest award at the 1876 Philadelphia centennial and was being specified by Army Corps of Engineers for their work along the Mississippi River. Americans adopted Portland cement slowly in the late nineteenth century. Although the use of natural cements had ceased in Europe by 1900, Portland cement composed only 28 percent of the cement manufactured in the United States by 1896 and two-thirds of this production came from the Lehigh Valley. However, after the turn of the century, American production rose rapidly. Although distributed from Louisville Kentucky, the Army Corps specified the same brand name in the reconstruction of the Fort Winnebago Lock in 1890 (U.S. ACE [Report] 1839-1963 [serial 2832, Doc. 1, pt. 2, vol. 2, pt. 3, 1890: 2365-66, 2388-89]; Elliott 1992: 160-62; Condit 1968: 158-59).

The Army Corps chose to use reinforced concrete when replacing the Portage Lock between 1926 and 1928. The properties of reinforced concrete which combined the compressive properties of cement and the tensile strength of steel became understood by 1854 through the work of Englishman William 8. Wilkinson. Thaddeus Hyatt established the essential principles of reinforced concrete by 1877. He ★

understood the importance of the bond between concrete and iron, of its placement at the base of most structures for tensile strength, and of the use of a network of rods or straps to bond the structure together. An Englishman who immigrated to the United States, Ernest Ransome was responsible for major advancements in the practical application of reinforced concrete in building construction in his 1884 patent. Until the second decade of the twentieth century, engineers in the United States remained skeptical about the properties of this material.

Through the 1890s, Americans tended to use a dry mix which actually weakened its strength. New methods of distribution of concrete at the construction site led to the development of a wetter mix. As labor costs rose, contractors began to develop mechanical methods of distributing the concrete to the formwork. By 1910, rather than mixing individual batches in wheelbarrows, contractors had begun to mix the cement at hoist towers placed at the center of the site. They attached chutes and tubes to the steam hoist and derrick which distributed the concrete from the tower across the site for a distance as great as 500'. If distributed by chute for too great a distance, the concrete would separate and produce a weak structure. Clearly evident at the Portage construction site (photographs WI-104-50-54), this method of distribution thus required a wetter mix which generally produced a stronger, more watertight concrete. By 1912, it was realized that the amount of water in the mix, a major element in controversies surrounding the use of concrete, was critical to its strength. Thus, by World War I, the method of mixing concrete, its distribution, and the development of reinforced concrete with the rebar placed at the points of tension and as a web to bond the concrete were established (Elliott 1992: 153, 168-86; Chorpeneing 1953: 1013; Condit 1968: 168-69, 240-41).

Beginning in 1891, the Army Corps used this developing technology to pioneer the design and construction of reinforced concrete lock structures along the Hennepin or Illinois and Mississippi Canal in Illinois. Associated with the operation of the Fox Waterway in the late 1880s while at the Milwaukee District, Major W.L. Marshall supervised the design and construction of the locks. The overall design paralleled those used by Colonel D.C. Houston along the Fox Waterway during its renovation in the 1870s and 1880s. Rather than the more expensive European cements normally used for such projects, Marshall employed American Portland cement. Typically, construction with concrete at this time involved pouring a series of relatively thin horizontal layers which were permitted to dry between pours. This method created planes of weakness between the layers so that the whole did not act as a monolithic structure. Rather than building the usual horizontal forms, Marshall directed the construction of forms to create vertical sections. The walls were poured continuously in alternating sections to create a single monolithic structure now characteristic of concrete construction. To maintain this pace, concrete was mixed in large batches, consuming five to ten barrels at one time. This approach also reduced the effect of a barrel of low quality cement on the whole. Previously, contractors prepared concrete by hand in wheelbarrows or in small mixers. The elevated cement mixer placed in the hoist tower designed for the project became the precursor to the current-day cement mixer. The construction processes developed along the Hennepin were later applied to other Army Corps projects such as the concrete construction during the 1920s at Portage and American building technology in general (Rathbun Associates

1984: II-15-16; O'Brien, Rathbun, and O'Bannon 1992: 113, 125; Tweet 1984: 157-66).

The miter gates along the Portage Lock which were installed late in 1927 were steel rather than the wood lock gates typically used along the Fox Waterway (Register-Democrat 1927 [10/20: 1/6]). The use of steel as a structural member was relatively common with the development of high rise buildings and its use in long-span bridges by the twentieth century. Between 1880 and 1908, the world-wide output of steel had doubled and in the United States it had grown five-fold. The members of the steel gates along the 1926-28 Portage Lock are riveted together. The use of hot rivets was introduced through the ship building industry and adapted by 1848 to the construction of iron bridges in England. Because rivets shrank as they cooled, they provided a strong connection. By the early twentieth century, riveting had become a common means of connecting steel frame buildings. Although electric arc welding which eventually replaced riveted connections was introduced by 1885, acetylene was not developed to make welding a practical process and replace riveting until 1940. Thus, the riveted steel used in the Portage lock gates was a very common form of connection for the period in which they were manufactured (Elliot 1992: 100-103; Condit 1968: 125, 147).

The chronological sequence of lock construction along the Fox Waterway included two timber locks; composite locks; ashlar stone locks; and concrete locks. The first Portage and Fort Winnebago locks and those at Rapid Croche and De Pere represent the only timber locks along the waterway. Most of the locks along the Fox were originally composite structures. Both the second Fort Winnebago and Portage locks were constructed in this fashion. The Army Corps replaced many of the composite locks along the Lower Fox in stone. The agency also built five stone locks along the Upper Fox shortly after acquiring the waterway in 1872. It did not replace the four existing locks on the Upper Fox including the Fort Winnebago Lock with stone locks, but with one exception repaired and rebuilt them. After its initial construction in 1858 as a composite lock, the Fort Winnebago Lock was rebuilt and extensively renovated using this same construction two more times before the composite lock was dismantled in 1959-60 (Table 1). Between 1926 and 1939, the Army Corps replaced five locks with reinforced concrete structures closed with steel gates. The Portage Lock became the first of these concrete structures to be built. However, this lock like the rest of the system retained the hand-operated gate mechanisms, the spar and tripod assembly (Richards 1995: 10; Meindl 1991; Vogel 1993; Meindl 1991: 36).

DEVELOPMENT OF THE FOX-WISCONSIN WATERWAY

The Portage

The portage gained significance as early as the 1670s as part of the Fox-Wisconsin waterway which carried furs gathered west of and in Wisconsin to eastern markets. Exploring the Upper Mississippi, Father Louis Hennepin noted the portage between the two rivers as early as 1680 (Hennepin 1938: 124-26).

Existing nineteenth century maps illustrate the Portage crossing the 1.5 miles interval at its narrowest width (figure 6). This location is approximately identified as Wauona Trail or Bronson Avenue. Until 1850, the portage forked with one leg ascending the hill to the northwest and the other going directly west to the Wisconsin. In 1766-1767, Jonathan Carver characterized half of the Portage as a marsh and the other portion as an oak plain. By 1822, Henry Schoolcraft described the wagon road crossing the Portage which Shaw has denoted as a corduroy road. He also referred to the periodic flooding occurring over the lowland between the two rivers during high water (Carver 1766-67: 41-42; Schoolcraft 1821: 363-64; U.S. ACE [Report] 1839-1963 [serial 359, S. Doc. 318, 1840: 23]; Turner, A.J. 1904: 89-90; Shaw 1888: 222).

By the mid-eighteenth century, French traders in the Upper Mississippi District with the Menominee, Winnebago, Fox, Sac, and Potawatomi used Green Bay as their base of operations. Because its northern location reduced spoilage, the Fox-Wisconsin Waterway as opposed to the Mississippi River became a favored route along which to transport the furs. Although the portage may have periodically served as a meeting place and point of distribution of goods and collection of furs by the late 1600s, the nearby Fox blocked the passage of French traders along the Fox Waterway until the end of the Fox wars between the 1690s and the 1730s and 1740s (Turner, F.J. 1889: 70-72; Grignon 1904 [1857]: 223-24).

The volume of the fur trade and level of contact intensified after the British gained control of the Mississippi Valley. The trading patterns established by the French by the 1740s and 1750s generally continued under British rule beginning at the close of the French and Indian War in 1763. After 1770, the traders gradually established temporary sub-posts or wintering quarters closer to the territory of the Native American groups. Furs were brought to the wintering quarters in the spring and taken to the rendezvous point or main posts in the early summer. Then, accounts were settled with each band and the next year's arrangements consummated. By the 1760s, the use of the portage as a minor rendezvous point had probably begun. Pinneshon, a deserter from a French garrison in Illinois, became the first known settler at the portage by 1766. Jonathan Carver noted the presence of the Frenchman as he crossed the portage in that year. Although he may have engaged in trading, Pinneshon moved at least goods and probably the large mackinaws across the portage.

After the closing of the French forts in the early 1760s, French traders continued to winter at interior settlements such as Green Bay and Prairie du Chien. The regional administrative headquarters where furs were deposited and trade goods received shifted from Green Bay to Mackinac. With the onset of the Revolution, the hostilities between groups supporting the British and Americans tended to turn traders away from the Upper Mississippi Valley to the northwest until 1783. Despite the peace treaty of 1783, the British retained control of the fur trade from their Canadian posts until the War of 1812. The Jay Treaty of 1796 stipulated that the British evacuate posts occupied in American territory, but it allowed both nations to engage in the fur trade on either side of the boundary.

After 1783, British traders began to form fur companies to deal with the rising

number of competitors. As a group of British traders formed the North West Company and held a monopoly over the trade along Lake Superior and to the west, independent traders many of whom were headquartered at Prairie du Chien turned to the Upper Missouri. Green Bay and Prairie du Chien at either end of the Fox-Wisconsin Waterway remained bases of operation for French traders who traded along the Upper Mississippi including Wisconsin. They continued to operate successfully as independent traders, often forming short-lived partnerships, until after 1803 when the center of trade shifted to St. Louis which served the Missouri basin. Traders at Green Bay at the end of the eighteenth century included Charles de Langlade, Pierre Grignon, Jacques Porlier, John Lawe, Joseph LeRoy, and Jacques Vieau. John Campbell, a Scot, located at Prairie du Chien. These traders or their representatives periodically traded in the vicinity of the portage.

By the 1770s and 1780s, the portage served as an established crossing and gathering place for traders and Native Americans. In 1787, Joseph Ainse described his arrival at Green Bay, his ascent of the Fox, and the meeting and gift exchange with the Puant or Winnebago at the portage. Robert Dickson, an English trader, described two usual routes from Mackinac to the Mississippi in 1793. One route was through Chicago and the other preferred route was the Fox-Wisconsin Waterway. He noted that when the water was high canoes passed over the portage between them without unloading (Thwaites 1892: 134-35; 1904: 187).

Primarily Green Bay traders or their representatives began temporary settlement at the portage with increasing frequency by the 1790s. Some also continued to operate a transport business. In 1792-1793, James Porlier and Charles Reaume traded and transported goods for a short period. Laurent Barth obtained permission from the Winnebago to transport goods across the portage in 1793. He and subsequent operators hauled goods and the mackinaws on carts. Engaging in the fur trade as an independent trader and selling his furs at Mackinac, Barth also established a small trading post and constructed a cabin at the west end of the portage. He first located on the lowlands of the portage and removed to higher ground in 1794. In 1798, Jean Lecuyer established a similar business, placing himself at the east end of the Portage. John Campbell purchased Barth's business rights in 1803, and Barth departed. The business of portaging boats continued into at least the 1820s. In 1797 and 1798, Jacques Vieau, who is usually associated with Milwaukee, wintered and traded at the portage. In 1801-02, Augustin Grignon, a noted trader, also wintered at the portage. They presumably provided the Winnebago with supplies and collected their furs for transportation to Mackinac (Gilman 1982: 6-11; Kellogg 1968 [1925]: 307; 1935: 17, 94-96; Thwaites 1882: 148-50; 1906: 10-15, 22-25, 135-39, 323; 1908a: 280-282, 333-34; Vieau 1888 [1797-98]: 2218-23; Turner, F.J. 1889: 93-94, 97-98; Turner, A.J. 1904: 45; Nesbit 1973: 34, 42-45, 58-60; Grignon 1904 [1857]: 286-87; Smith 1973: 49, 76-81; Ellis 1908 [1876]: 240).

In the early nineteenth century, the federal government conducted explorations of the western Great Lakes and Upper Mississippi River. Several of these trips crossed the portage between the Fox and Wisconsin rivers. Major Stephen Long, the first member of the Army Corps of Engineers to explore the Upper Mississippi River, examined the route along the Wisconsin to the portage from the Mississippi

River in 1817. Between 1816 and 1818, he surveyed the Illinois, Fox, Wisconsin, and Minnesota rivers making preliminary assessments of potential navigation along them. Colonel Henry Leavenworth crossed the portage on his way to the site of Fort Snelling in 1819. Henry Schoolcraft and James Duane Doty accompanied Governor Lewis Cass as he traveled along the boundaries of the territory he governed. At the end of his trip, Cass went from the Mississippi, up the Wisconsin, and across to the Fox River on his return trip to Detroit in ca. 1820. Captain David Douglas Bates, topographer of the Army Corps of Engineers, assisted Cass with the examination of the area for navigable waterways (Smith 1973 166-68; Larson 1979: 6-7-11; Tweet 1984: 37).

In and following 1805, several chronologically sequential Canadian-based companies composed of independent traders formed to limit the ruinous competition among the individual traders by assigning specific trading areas to each member. After the War of 1812, the Americans gained control of the final years of the fur trade. Buying out his Canadian partners included in the South West Company by 1811, John Jacob Astor re-established it as the American Fur Company and dominated the Wisconsin fur trade after 1815. Astor operated his company by either hiring agents to manage the trade in specific regions or contracting with independent traders who dealt only through the American Fur Company. Under either system, the agent or trader worked on commission receiving trade goods and supplies on credit and selling their furs to the company at its prices. As the fur harvest waned, Astor profited while his agents accumulated debts to him. By operating in this fashion, Astor absorbed many of his competitors. When Astor retired from the fur trade in 1834, the company underwent reorganization under the ownership of Hercules Dousman, Henry Sibley, and by 1840 Joseph Rolette.

The general pattern prevailing during the British era of trade remained. With the introduction of the steamboat on the Mississippi by the 1820s, trade goods often came up the Mississippi rather than across the Fox-Wisconsin waterway. Prairie du Chien became a major distribution point for goods. But, traders preferred the northern route for the shipment of furs to eastern markets to prevent spoilage. They continued to ship furs east along the waterway, carrying their goods across the portage between the rivers to Mackinac and onto New York (Fonda 1907 [1828]: 235). In the first decades of the nineteenth century, the most common means of conveyance along the Fox appears to have been the Durham boat. Because the distances made transportation difficult, small traders frequently purchased Native American furs and stored them for sale to more substantial traders during the trading season.

In 1842, the American Fur Company failed, and fur trade activities were controlled by the Chouteau Company at St. Louis which primarily operated along the upper Missouri. As settlement expanded from the lead mining centers in southwest Wisconsin, Native American populations were removed. The number of fur bearing animals significantly declined, and the fur trade waned rapidly after 1830 (Gilman 1982: 11-18; Nesbit 1973: 66-69, 86-87; Turner, F.J. 1889: 83, 85; Merrell 1908 [1876]: 370).

Established to serve the fur trade, settlement at the portage had become semi-permanent by the early 1800s. The Grignons first appeared at the Portage between

1801 and 1803. Members of the family including Augustin, Perrish, Lavoin, and Louis Grignon either stopped or wintered at the Portage until about 1823. Members of the family acted as independent traders periodically combining with other traders such as John Lawe at Green Bay (Thwaites 1911: 132-33; 232; De La Ronde 1908 [1876]: 347). After 1810, Laurent Filey and in 1812 Joseph LeRoy, his son-in-law, continued the transport business of Lecuyer. Both maintained a store of goods and traded with the Winnebago. In 1828, LeRoy sold his property to the United States Army prior to the construction of Fort Winnebago and moved to the west side of the Portage where he remained until at least 1831. Begun in 1828, Fort Winnebago was constructed on a hill above and to the northeast of the portage. It was erected in part to provide protection to traders, primarily the American Fur Company, along this strategic route between Mackinac, Green Bay, and Prairie du Chien. Erected in 1832 by John Kinzie who was sub-agent for the Winnebago, the Agency House stood a short distance north of the Portage and the site of the canal and northwest of the fort. The Fort Winnebago lock would sit southeast of this building. Completed between 1835 and 1837, the Military Road, a major route also connecting Green Bay to Prairie du Chien, crossed the portage (Grignon 1904 [1857]: 285-289; Thwaites 1910: 368; Whittlesey 1903: 75; Schoolcraft 1821: 363-64; Lockwood 1856 [1817]: 108-09; Center 1833 [map of the Military Road]; Merrell 1908 [1876]: 374; La Ronde 1908 [1876]: 346; Smith 1973: 436).

In 1821, the American Fur Company established itself at the portage. The Southwestern Fur Company acquired the fur trading post located at its east end and a short distance northeast of the site of the Agency House and across the Fox from the site of Fort Winnebago in 1808. Joseph Rolette purchased the post as an independent trader in 1815 and sold it to the American Fur Company in 1821. The company maintained a series of traders at the post including Pierre Pauquette who became established perhaps by 1824 but before 1827 and remained until 1834. By 1828, the post included a log house, barracks, and a barn. Henry Merrell, also the fort sutler, succeeded Pauquette and represented the American Fur Company in 1834. John Baptiste Ousay became the American Fur Company agent at the post in 1839. Following its usual practice, the American Fur Company furnished him goods on shares. The post remained under the ownership of the American Fur Company until 1851 when Hercules Oousman transferred his rights to the post to John Baptiste Ousay. Ousay occupied the post until his departure in 1857 following the shooting of John Reynolds who had participated in the construction of the Portage Canal. His departure represented the close of fur trading activities adjacent to what had become the City of Portage (Krug 1946: 29-30, 81, 90, 140; 191-99, 207-15; Turner, A.J. 1903: 2-4; Merrell 1908 [1876]: 373, 382-84; De La Ronde 1908 [1876]: 346; Williams 1835; Morgan 1888: 387; Williams 1835).

By 1828, Daniel Whitney, an independent trader from Green Bay, established a warehouse for supplies at both ends of the Portage. He was likely providing his agents and other small traders with goods in the local trade. Unlike other traders, he did compete successfully with Astor perhaps in part because he operated multiple enterprises. Whitney engaged in lumber milling, operated the Helena Shot Tower, speculated in lands, and became associated with the Portage Canal (Nesbit 1973: 94-95; Thwaites 1900: 452-53; Turner, A.J. 1903: 39-40;

Merrell 1908 [1876]: 369; Morgan 1888: 387; Libby 1895: 338-40 344). The sutler at Fort Winnebago as well as several other agents established near the fort also provided voyageurs and traders with necessary supplies. Representing Oliver Newberry of Oetroit, Saterlee Clark served as fort sutler beginning in 1830. Later briefly associated with the canal in its early years of development and a Portage businessman, Henry Merrell became the fort sutler between 1834 and 1838 (Merrell 1908 [1876]: 391; Clark 1908 [1876]: 311; Butterfield 1880: 430).

Early Promotion of the Portage Canal and the Fox-Wisconsin Waterway: 1828-45

As noted, the Fox-Wisconsin Waterway became one of several waterway improvements promoted during the territorial era in Wisconsin (Mermin 1968: 4). In the late 1820s and early 1830s, Wisconsin's inland waterways did not provide reliable transportation. Hazardous travel along the Wisconsin with its periodic low water and shifting sands, the marshy portage itself, and the rapids of the lower Fox presented serious obstacles to shipping along the Fox-Wisconsin Waterway. Ice blocked this waterway and all other inland waterways in the region during a portion of the year. Shipping on the Fox by the 1820s and through the 1830s continued to be limited to canoes and durham or flat bottom boats which could be portaged around the rapids and across the portage. By the early 1840s, small steamboats appear to have pulled these boats along navigable portions of the Fox River. The lead shipments went to forts Winnebago and Howard, Oetroit, and Buffalo. Whether or not large quantities of lead in fact went along the Fox-Wisconsin route (see Clark 1955: 5), it was a sufficiently valued commodity about which to initiate the promotion of the waterway.

The promoters of the Fox-Wisconsin Waterway sought a reliable system to ship their products to eastern ports: to carry lead to the Great Lakes from the southwest mining district; to transport bulk agricultural products, particularly wheat, to the Great Lakes ports; and to move other natural resources such as timber. The expense of freighting wheat, the main cash crop, long distances across south central and southeast Wisconsin to the lake ports was almost prohibitive. Freighting absorbed much of the income derived from its sale. Wisconsin farmers required some form of inexpensive, long-distance transportation to survive.

Shipments of lead to Detroit followed the waterway as early as 1822. Henry Oodge sent lead along the Fox-Wisconsin Waterway to Green Bay by 1829. Daniel Whitney, sought a route along which he might conveniently ship his lead shot from Helena and maintain his supply warehouses for the fur trade at the portage. Whitney began lead shipments along the waterway in the early 1830s and continued them until about 1839. Since Missouri lead dominated the Mississippi market, Wisconsin lead tended to travel east across Wisconsin either by this route or, especially in the late 1830s and early 1840s, by wagon to Milwaukee.

In the 1820s and 1830s, improved waterways constituted the only viable alternative for long-distance shipment of bulk loads. Recently completed in 1825, the success of the Erie Canal provided the solution, and the rampant speculation of the era supplied the impetus to complete such experiments.

Townsite promoters, land speculators, early industrialists, businessmen, and politicians, often the same individuals, with Wisconsin's farmers pressed the territorial and federal governments for river improvements. Daniel Whitney and Morgan L. Martin with others of Green Bay lobbied for the improvement of the Fox-Wisconsin Waterway in 1829. During the territorial period, Congress received a relatively constant flow of memorials for the improvement of the Fox-Wisconsin Waterway from the legislatures of the territory of Michigan and the territory of Wisconsin, established in 1836.

Martin and Whitney proposed the improvement of the Fox with channel excavation, canals circumventing the rapids, and lift lock and dam systems to overcome the drop between Portage and Green Bay. They supported the excavation of a canal across the 1.5 mile wide portage and at least superficially recognized the need to improve a channel along the Wisconsin. In the speculative era of the 1830s, Whitney and Martin were able to promote and raise funds for the improvement through a number of schemes which ultimately relied on the largess of the federal government to support a public thoroughfare (Smith 1973: 448-49; Childs 1906 [1855]: 183; Sutterfield 1880: 589; Meindl 1991: 13, 18; Mermin 1968: 17; Libby 1895a: 306-10, 313, 316; 1895b: 338, 344, 357-58; Taylor 1951: 154; Clark 1955: 3-5; U.S. ACE [Reports] 1839-1963 [serial 346, H. Doc. 102, 1839: 8-9]¹).

The Portage Canal became the initial emphasis of the Fox-Wisconsin Waterway improvement project. A public meeting at Green Bay petitioned Congress to improve the waterway in 1829. Under the guidance of Morgan L. Martin, the Summit Portage Canal Company and Road Company was incorporated under the laws of the Territory of Michigan with a capital stock of \$10,000. The company proposed to construct a canal and adjacent turnpike road between the Fox and Wisconsin. The Michigan Territory incorporated the company in 1829. By January 1834, it proposed to excavate a canal 5' below the surface of the Wisconsin River, 28' feet wide at its base, and 33' wide at its surface. After numerous time extensions, this company proved unable to fulfill its commitments (Mermin 1968: 17; Meindl 1991: 19; East Central Wisconsin Regional Planning Commission 1948-85 [letter, 2/4/48 from R.A. Wheeler, Chief of Engineers Office]; Martin 1888: 403; Fox-Wisconsin River Improvement Company 1829-51: 1-6; Sambery Papers 1866-1960 [copy of articles of incorporation, 10/23/1829]).

In March 1834, the Michigan territorial legislature incorporated the Portage Canal Company to accomplish the same task as its predecessor. Shareholders included Daniel Whitney, John Lawe, Henry Baird, and John Arndt. While constructing the shot tower in Helena in 1835, Benjamin Webb, a representative of Daniel Whitney, sent John Wilson with sixty men to dig a canal across the Portage approximately along Wauona Trail (figure 6). High water ended their activity. The effort produced what was described as a two foot wide by one foot deep ditch sufficiently deep to accommodate canoes (Libby 1895a: 307; 1895b: 345-46; Meindl 1991: 19; Martin 1888: 403-04). However, a group of merchants did privately begin the construction of a wooden lock and dam at De Pere in 1835.

¹ This citation refers to the report by John B. Petitval of the Topographic Engineers on the navigation of the Fox River.

Completed by 1848, this improvement eventually became incorporated into the Fox Waterway. Associated with John Lawe, the Fox River Hydraulic Company existed briefly between 1836 and 1838. Its goal had been to construct a 4' deep by 20' to 36' wide canal with a 4' lift lock across the Portage (Meindl 1991: 19; Mermin 1968: 2; Fox-Wisconsin River Improvement Company 1829-51: 7-15, 37-39).

After the Portage Canal Company also failed, Whitney with eastern capitalists some of whom were also trustees of the Wisconsin Shot Company including DeGamo Jones, Sheldon Thompson, Robert McPherson, and S.P. Griffith reorganized the Portage Canal Company in 1838. This same group claimed ownership of the Grignon Claim in Portage for a brief period (Portage Canal Company n.d. [map]; Butterfield 1880: 610; Martin 1888: 403-04). The company received estimates for completion of the canal and locks from Benjamin Wright associated with the construction of the Erie Canal, Daniel Whitney of the company, and Orlin S. Trusdell of Madison. In 1838, Trusdell began the 7'-6" deep by 30' to 50' wide canal with a single timber lock of 35' x 140'. These improvements totalled \$10,000. Although work ceased as the depression of the late 1830s continued, the company remained in existence until at least 1842 when it maintained a warehouse at the portage.

In 1838, Morgan Martin with support from Brown County citizens continued to promote the project to the territorial legislature. The legislature responded with two memorials to Congress. The memorials emphasized the military and commercial importance of the waterway to substantiate the request for a land grant of odd-number sections along five miles of the banks of the Fox. The legislature also sought a parallel grant for improvement of the Rock River and funds to remove obstructions from the Wisconsin River and improve the Mississippi River. Similar memorials by the legislature were repeated between 1839 and 1846 (Mermin 1968: 4-5; Libby 1895b: 339; Meindl 1991: 19; Fox-Wisconsin River Improvement Company 1829-51: 42-67; Bamberg Papers 1866-1960 [copy of articles of incorporation, 3/7/34, 6/20/38, 1/13/1840]).

In the interim, the War Department completed surveys along the Fox and Wisconsin rivers and across the portage to establish the most practical method of improvement. Lieutenant Alexander J. Center began a survey which included six miles of the Fox River near Green Bay in 1836. Colonel John B. Petitval of the Topographical Engineers completed a brief survey of the Fox River in 1837. In it, he described the physical characteristics of the different sections of the river including the locations of significant navigation obstacles. Petitval gave limited support to the improvement of the Fox-Wisconsin Waterway, warning that the canal across the portage would be a costly undertaking. He also described the two other routes competing for federal support, the Illinois River as well as Rock with the canal to Fond du Lac in the same report (figure 7) (U.S. ACE [Reports] 1839-1963 [serial 346, H. Doc. 102, 1839: 5-11]).

At the request of the War Department in 1838 and in response to numerous petitions from the citizens of Wisconsin, Congress appropriated funds for a second survey which was conducted by Captain Thomas Jefferson Cram of the Corps of Topographical Engineers in 1839. Cram, who was then stationed at Racine, surveyed the Fox but not the Wisconsin River. He strongly supported the Fox-

Wisconsin Waterway in favor of the improvement of the Rock and Illinois rivers. His 1840 report pinpointed the locations for the locks, dams, and canals to overcome the rapids and 169 foot drop between Lake Winnebago and Green Bay. Lock chambers were to measure 30 by 110 feet, and canals were to reach 5' deep, 40' wide at the bottom, and 55' wide at the surface. Dams were to be constructed at each of the rapids. He recommended locks and dams at Oe Pere, Kaukauna, Combined Locks, Rapide Croche, Little Chute, Appleton, and the Winnebago Rapids. Cram advised the removal of sharp curves, bar deposits, and trees at the banks along the Upper Fox River, but he did not recommend the construction of locks and dams. His report indicated a new location for the proposed 7739' long x 40' to 55' wide Portage Canal to the north of the 1835 effort. Cram advised the construction of a lift lock at the Fox River end and a guard lock at the Wisconsin River end of the canal to prevent flooding of the canal from the Wisconsin River and protection of the banks of the canal. He estimated the modifications along the Fox at \$448,470 and provided no cost estimate for the improvement of the Wisconsin River. Cram acknowledged that low water along the Wisconsin inhibited navigation because of its shifting sandbars and suggested that boats of a small enough size could be constructed to overcome the problem (U.S. ACE [Reports] 1839-1963 [serial 490, H. Doc. 551, 1846: 1-18; serial 1744, H. Doc. 1, pt. 2, 1877: 208-10 and map]).

In sum, Cram recommended the canal's construction because of the military and economic importance of a waterway connecting the Great Lakes to the Mississippi for not only Wisconsin but for adjacent states and those west of the Mississippi. The supervising committee for the survey recommended public support of the project through a series of land grants. This study which included the optimistic recommendations about navigation on the Wisconsin and the low estimates for the cost of improvement guided the engineering approach to the improvement project for the next twenty years (Meindl 1991: 19; Wisconsin Division of Historic Preservation n.d. [memo from Richard W. Henneger, 3/31/76]; Mermin 1968: 5-10; Schaffer 1937: 82-91; Libby 1895: 345-46; Smith 1954: 188; 1973: 455-57; Raney 1940: 109; WPA 1938: 40-41; Larson 1979: 38-39, 48-49).

In 1838, James Doty proposed management of the project by a territorial board and its funding by a federal land grant and loans. The legislature failed to support the proposal because of the limited capital in the territory. When he became territorial delegate, he also promoted his plan to Congress. Although Doty's efforts on behalf of the improvement failed, he sustained public interest in the project. Between 1838 and 1846, there were a continuous series of petitions for federal assistance (Mermin 1968: 10-11, 56).

In 1843, Senator Nathaniel P. Tallmadge began to speculate in land adjacent to Fond du Lac and thus possessed a vested interest in improving its value. Corroborating with Doty, Tallmadge introduced a bill to Congress in 1844 which provided a land grant of alternate sections of land two sections in width or 320,000 acres along the Fox and the Portage Canal. The federal lands were to sell at \$2.50 per acre. The bill was much debated and supported by legislative memorials from the territorial legislature in 1844 and 1845. An added appeal to overcome constitutional scruples became its use to convey troops and munitions to the western frontier. War with England over the Oregon Territory had become

a real concern in the mid-1840s. Morgan Martin replaced Tallmadge in Congress as proponent of the bill in 1845. Martin presented petitions from the territorial legislature and private groups of citizens early in 1846. Congress authorized the bill with little debate in the summer of 1846 (Mermin 1968: 13-18; Schaffer 1937: 97).

Advocates for the Fox-Wisconsin Waterway had pressed Congress for its improvement during the speculative era following the completion of the Erie Canal in the late 1820s and early 1830s. The level of promotion for internal improvements encountered in Wisconsin, then, was a typical phenomenon for the times. The desire to move goods along a through route from the interior of Wisconsin to the expanding eastern markets so that its farmers and its fledgling industry might prosper was great. However, federal funding became quite limited at the beginning of the Jackson Administration in the 1830s and remained so in the 1840s when the Democratic Party dominated Congress. During this period, the states completed many of the improvements by relying principally on loans and began to default their loans in the late 1830s at the onset of the depression. Loans for such projects became much less available from eastern and foreign sources by the 1840s. In the 1840s, the Wisconsin territorial legislature had no power to authorize funding and secure internal improvements. Wisconsin had to achieve statehood before it could accept this role. Support from the territorial legislature through its numerous memorials maintained the visibility of the project before Congress. Thus, during its early conception, the funding of Wisconsin's project faced much competition and required much promotion. A further impediment to the funding hurdle became the territory's receipt of 500,000 acres of land for the Milwaukee to Rock River project when the Whig Congress of 1841 parceled lands to the states. Wisconsin was to await statehood to receive Congress's largess. The 500,000 acres was applied to the school fund (Schaffer 1937: 93-94; Smith 1954: 187; Armstrong 1976: 39).

The State Board of Public Works: 1846-53

Pressed by such promoters as Morgan Martin, Congress eventually followed the recommendations made in the 1840 report based on the Cram survey. The federal land grant was recorded as Chapter 170 of the Acts of Congress dated August 8, 1846 (United States 1868-1958 [1846, Chapter 170]). Contingent on Wisconsin's statehood, Congress provided a land grant to the state in support of the improvement of the Fox and Wisconsin rivers and the construction of a connecting canal at the Portage. By its acceptance of the land grant as recorded in the laws of the state dated June 29, 1848, the state became responsible for the project's completion. The land grant was equivalent to one half of three sections in width on each side of the Fox including the lakes through which it flowed and the proposed site of the canal between the mouth of the Fox at Green Bay and the Wisconsin River side of the canal at Portage. Lands already entered within the odd sections were replaced with an approved section. Unlike the land grant for the canal along the Rock River, Congress placed the cost of the alternate sections which remained in government hands at \$1.25 per acre. And, the right of pre-emption was applied to these lands as to any public lands. The Wisconsin constitutional convention placed this stipulation in the 1848

TABLE 1

Major Construction Episodes of the Portage Canal and Its Associated Locks

<u>Component</u>	<u>Dates</u>	<u>Construction</u>	<u>Type</u>
Portage Canal	1849-51	Excavation/Timber Revetments	
	1858-59	Dredging	
	1875-76	Extensive Dredging Timber Revetments	
	1891-92	Repair	
	1902	Timber revetments	
	1897	Timber revetments	
	1916	Dredging	
	1927	Dredging	
	1959	Closed	
Portage Lock	1849-51	Built	Timber
	1877-78	Repaired	
	1880	Renovated	
	1892-93	Rebuilt	Composite
	1900	Repaired	
	1913	Repaired	
	1926-28	Replaced	Concrete
	1959-60	Deactivated	
Ft. Winnebago Lock	1849-51	Built	Timber
	1858-59	Rebuilt	Composite
	1874-75	Refurbished	
	1878-79	Repaired	
	1890	Rebuilt	Composite
	1900-01	Repaired	
	1936	Renovated	
	1959-60	Dismantled	

constitution which Congress accepted. The grant delegated the selection of the appropriate sections to the governor with approval by the President.

Congress included one significant restriction in the land grant. The Wisconsin legislature could sell only that amount of land worth \$20,000, about 16,000 acres, in any given period. No new construction began until the amount of land required to be sold was entered at the land office and land sales could not commence again until \$10,000 were expended on construction. In addition, the completed improvement was to function as a public highway free of tolls for the use of the United States government. The improvement was to reach completion in the twenty years following statehood (Schaffer 1937: 98-100, 104; Mermin 1968: 22-23).

The state constitution permitted the stewardship of this public improvement project because under the provisions of the land grant the state would not contract a debt for the internal improvement. Revenues generated from the improvement could also be applied to its completion. In 1848, the legislature formed the Board of Public Works composed of five and after 1849 three individuals appointed by the legislature. The board was to supervise the land sales, let contracts, and oversee the work. It located the state land office for these lands at Oshkosh. The legislature gave the board the right of eminent domain which permitted entrance onto and possession of all lands necessary for these improvements. It also granted the board the power to establish regulations for both construction and operation of the waterway. The governor became the general supervisor of the project. The board appointed the superintendent and engineer to oversee the construction. Condly R. Alton served as the first engineer until May 6, 1851 when Kip Anderson, the assistant engineer, replaced him. J.E. Day acted as the consulting engineer in 1851, primarily to substantiate decisions concerning construction. Day had worked on improvements along the Monongahela River and on other improvements in Pennsylvania. In June 1853, the board dismissed Anderson after work on improvement was suspended (Schaffer 1937: 100-103; U.S. ACE [Report] 1839-1963 [serial 1744, H. Doc. 1, pt. 1, 1876: 211-12]⁸; Mermin 1968: 21-22, 27; Green Bay and Mississippi Canal Company 1848-1909 [Board of Public Works, vols. 1-2]).

In 1848, Alton conducted surveys and prepared plans for the project, and the board supervised the land sales. The plans deviated from Cram's recommendations by the alteration of project depth from 5' to 4' and lock size from 110' x 30' to 140' x 30'. The width of the base of the canal was to measure 40', and the side slopes were to equal 1'-6" or 2'-0" to 1'. Alton intended these sizes to accommodate small, flat bottom, stern-wheel steamboats of eighty-ton capacity. Growing concern about the accommodation of the larger steamboats in the waterway in 1851 led to enlargement of the lock size to 160' x 35' and a 5' depth. The board required that locks at Kaukauna, Little Chute, Grand Chute, and Cedars conform to these specifications. Although the two locks at Portage and those at Rapid Croche and De Pere were completed with timber, locks built after 1851 were to be stone lined with timber or composite locks. Alton also examined two

⁸ This report was completed by Gouverneur K. Warren.

potential routes for the Portage Canal, both entering the Fox River near the Agency House and occurring north of the work finished in the 1830s.

In an act of March 6, 1849, the legislature instructed the Board of Public Works to begin the project with the construction of the Portage Canal followed by the improvement of both the Fox and Wisconsin rivers (Wisconsin, State of [Laws] 1848- [1849: 45]). The board prepared general specifications for the excavation of canals and for the construction of timber locks (Wisconsin Governor 1840-1914 [1844-50, folder 6, box 9, specifications]). On March 6, 1849, it advertised for bids to construct the canal's guard lock and lift lock, to excavate the two sections of the canal, and to protect the sides with timbers. The board let two separate contracts for the work on May 1, 1849. It let the excavation and the construction of revetment along the banks of two sections of the 2.25 mile-long canal to Thomas Reynolds of Madison for \$15,645. It selected Nelson McNeal of Southport or Kenosha to build both locks for \$21,479. Reynolds began excavation of the canal in June 1849, and McNeal appears to have commenced at about the same date. The original contract required completion on June 1, 1850. This deadline was extended several times so that the canal was finally completed by the June 9, 1851 deadline (Wisconsin Board of Public Works 1850-53 [box 1, statements dated 6/9/51]).

While the records of the Board of Public Works included general specifications for the canal and locks, the engineers and contractors did not necessarily follow them completely. The contract directed that the Board of Public Works pay 75 percent of the cost of the work whenever sufficient funds were realized from the land sales. The specifications defined a canal 4' deep at ordinary stages of water, 44' wide at the bottom, and 60' wide at the top. The towpath measured 10' wide. The specifications did not dictate the form of coffer dams to be erected. The construction of the canal included grubbing and clearing all trees and brush from the area of construction; excavating all perishable matter, loose stone, and porous soil and removing it from the area of the site; excavating within the area of the banks and depositing the dry and durable spoil when not needed as fill evenly along and at the same grade as the resulting bank; grading the embankments to the required slope; lining the canal bottom by puddling; and finishing the banks with plank revetments. Composed of pine planking and oak structural members, the revetments included 10' to 12' long, 8" x 10" posts driven into the slope of the inner face of the bank at 8' intervals. Wood coping ran along the top and timbers 3' to 4' long were driven back into the bank as supports. The piles carried 2" horizontal pine planking.

Few descriptions of the excavation of the canal were provided in the minutes of the Board of Public Works. Reynolds began his project by ditching and removing muck and surface soil so that the board's steam dredge could complete the excavation. The steam dredge was never made available. It is assumed that Reynolds completed the excavation through this wet soil with shovel and wheelbarrow rather than horse and scraper.

The Portage or Wisconsin River Lock at the west end of the canal functioned as a guard lock to prevent sand from washing from the Wisconsin into the canal. The Fort Winnebago Lock served as a lift lock between the Fox River and the canal.

Its location was altered slightly to secure a better footing shortly after the award of the contract. McNeal constructed both locks as timber structures. The specifications required locks measuring 35' x 140'. The side of the lock walls extended 28' west of the hollow quoins of the west gate. The board increased the length of the guard lock during or just after its construction in 1851 (Wisconsin Board of Public Works 1852: 81).

The excavation of the two lock pits proved to be very time consuming. McNeal received his timber by rafts of pine floated down the Wisconsin. Timbers packed with gravel and puddling between them composed the foundation. The specifications suggested the use of concrete if rock was used to support the walls. The miter sills were composed of oak timber while the contractor was to use white pine to line the floor. Except the top or coping timber which was oak, white or yellow pine composed the walls. Double docks or two adjacent tiers of timbers hewn on the upper and lower sides and secured with oak cross ties formed the full height of the sides of the lock chamber, wings, and recesses which received the gates. The timberwork was then finished with two layers of white pine planking set in place with treenails of white oak. White pine hollow quoin posts were framed into the miter sills and walls with iron screws. Composed of white oak timber frame covered with pine planking, the gates rested on a miter post placed between pivots or pintels. Balance beams maneuvered the gates. Banks at either end of the lock were revetted. The entrance to the Wisconsin River was also protected by sheet piling. The board purchased the valve gates and their hardware from Seymour and Wood of Utica, New York. The same gates were used along the Erie Canal. And, it acquired Henry McCarties' patent for suspending and opening and closing the lock gates on October 25, 1852 (Wisconsin Board of Public Works 1850: 552, 569-70; Wisconsin Governor 1840-1914 [folder 6, box 9, 1844-50: specifications]).

The legislature also authorized the construction of bridges across the canal between 1850 and 1852 (Wisconsin, State of [Laws] 1848- [1850: 48; 1851: 280; 1852: 342, 375, 612]). Thomas Reynolds signed a contract to erect a swing or draw bridge across the Portage Lock, and McNeal erected a similar bridge across the Fort Winnebago Lock. The crib work of the locks provided support for the bridges. The contracts dated May 20, 1850, and work had reached completion by January 1852, after a period of work suspension. Confirming the completion of this bridge, an 1881 map completed under the direction of D.C. Houston of the Milwaukee District of the Army Corps showed Lock Street traveling across the Portage Lock. Charles S. Hawley of the Town of Waukesha contracted with the board to build three wood float bridges across the canal between December 25, 1852 and July 1853. Specified in preceding legislation, the contract indicated their placement across Main, Center, and Wisconsin streets (Wisconsin Governor 1840-1914 [1852-53: folder 8, box 9]; U.S. ACE, Milwaukee District 1881).

The state accepted the canal as completed on July 3, 1851. At this time, the Board of Public Works met at Portage to formally accept the tract along the canal (figures 8-9). The tracts associated with the canal included one bordering the Fox, one along the Wisconsin River, and an 190' wide linear strip between the two rivers. The 190' right-of-way for the canal partially crossed the land grant received by the state. The remainder of right-of-way crossed platted lands. The

two conflicting claims along this section of the canal eventually caused the conflict between private land owners along the canal and the Army Corps of Engineers (8ambery 1866-1960 [folder 5, box 2, report by C.8. Davis, 5/31/1890]).

The flood of September 1851 broke through the banks at three places along the canal including locations near both locks. Limited repairs were quickly completed. The bank of Wisconsin River adjacent to the Portage Lock received cribbing to prevent a similar occurrence. Nelson McNeal received the contract for this work on November 12, 1851. J.E. Oay inspected the canal in late 1851. He pinpointed numerous problems in its construction. He found that the guard lock was insufficiently back-filled. The gates of both locks did not open their full width because of the defective shape of the hollow quoins. Section one, the west section, of the canal which was 48 feet wide at the base proved too narrow to admit the passage of steamboats. The 80' width of section two was sufficient, but the bank required raising above the water line of the Wisconsin River and needed greater stability. The planking had been improperly attached to the sides of the canal. It required rebuilding by driving the piles well into the bank. The planking had floated to the top of the water line when water was let into the canal. Finally, a waste weir had not been built at the east end of the canal.⁹ The revetments along the sides were to be repaired after the widening of first section of the canal (Schaffer 1937: 102-03; U.S. ACE [Report] 1839-1963 [serial 1744, H. Doc. 1, pt. 1, 1876: 211-12]; Green Bay and Mississippi Canal Company 1848-1909 [Board of Public Works, vols. 1-2]; Wisconsin Governor 1840-1914 [1851: folder 7, box 9, letter from J.E. Oay]).

The delay of work along the canal under both contractors resulted from the inexperience of the contractors, engineer, and the board in gauging the amount of work required to build such a structure as well as the approach to constructing both the canal and the locks. Outside of the Army Corps of Engineers, the number of engineers experienced with the improvement of waterways remained few in number even by the early 1850s. This problem was exacerbated in newly settled areas such as Wisconsin. Thomas Reynolds claimed additional costs in excavating the canal. The board considered Reynold's case on October 20, 1851 at Fort Winnebago. The claim of damages due to Reynolds was based on the belief that the board had agreed to use the dredge to complete excavation along the canal and that high water had continually delayed his work. Time and cost overruns without the use of the dredge had been considerable. Reynolds thus held the board in breach of contract. The board found against Reynolds on October 22, 1851. The poor quality of his work particularly in the construction and attachment of planking along the sides of the canal may explain their reluctance to acknowledge his claim (Wisconsin Governor 1840-1914 [1851: folder 7, box 9]). In 1852, the legislature settled with Thomas Reynolds, granting him \$10,000 for his losses. It also paid McNeal an additional \$7,500 to compensate him for his

⁹ An undated map of the east end of the canal showing the mill and Fort Winnebago Lock which were both extant by 1852 does not illustrate the waste weir (U.S. ACE, Chicago District n.d., 1873-1928 [undated map, 13-C-2, tube 71/204]). The waste weir associated with the Fort Winnebago Lock was probably not constructed until after 1873 (U.S. ACE, Chicago District, 1873-1928 [map, n.d.]).

additional work (Mermin 1968: 203).

In 1849, Alton noted the considerable value of the Fox River's waterpower for industrial and commercial purposes. The legislature directed the board to consider bids offered to enhance the development of waterpower along the improvement in 1850 (Wisconsin, State of [Laws] 1848- [1850: 226-27]). Much of this development occurred on the lower Fox River. However, under direction of the legislature, the board did lease the waterpower at the Fort Winnebago Lock to Joseph Burger for thirty years on January 1, 1853 (Wisconsin, State of [Laws] 1848- [1852: 690]; Wisconsin Governor 1840-1914 [1852-53: folder 8, box 9]). Burger erected a mill at this site immediately east of the lock. The entrance to the head race left the canal along its southeast bank southwest of the Fort Winnebago lock. The tail race connected to the Fox River just east of the canal entrance (figure 8). This improvement appears to be the same waterpower leased by Nelson McNeal by 1855. The mill continued to stand through 1868 (U.S. ACE, Chicago District 1873-1928 [map, n.d.]; Merrell 1888: 400; Haslam and Abbott 1855; Ligowski 1861; Rugen 1868).

On October 3, 1848, the Board of Public Works contracted with Abel Hawley for the building of a dredge to open the section between the Portage Canal and Oshkosh on the Upper Fox. It intended to improve the Upper Fox River by dredging rather than building a lock and dam or slack water system. During the ensuing four years, the dredge worked deepening the channel and making cut-offs across some of the many sharp bends in the river. Lumbermen used this section of the waterway and the Portage Canal to move timber from the Wolf River to the Wisconsin and Mississippi rivers.

Awarded contracts and agreements for work on the Lower Fox River included improvements of the rapids at De Pere (1849-51), Rapide Croche (1849-51), Winnebago Rapids at Menasha (1849-), Grand Chute or Appleton (1850-), Kaukauna (1851-), Cedar Rapids (1850-), and Little Chute (1852-). Work at Grand Rapids and the canal at Neenah were also begun during this 1849 to 1852 period. Joshua Cox agreed to complete the replacement of the lock at De Pere for \$1 perhaps to garner income from anticipated commerce. In 1850, Curtis Reed offered to improve the Winnebago Rapids for the privilege of developing its waterpower. To press the project forward, Morgan Martin contracted with the board to complete the improvements at Kaukauna and Little Chute in 1851 and 1852. Except for two locations, the construction of lift locks and dams remained generally unfinished by 1853. In its annual report for 1852, the board noted the importance of completing the project because railroads and the plank roads sought connections with the waterway. Such traffic was perceived as adding substantially to the revenues of the project rather than competing with it.

Because of its numerous channels and sand bars, the engineer reported in 1849 that the creation of a navigable channel along the Wisconsin River required more work than initially realized by Cram. He suggested the removal of the snags and trees overhanging the banks and the cutting of a new channel along the sloughs between Bridgeport and the Mississippi. In 1852, the legislature directed the board to begin work along the Wisconsin River. At this time, it set aside one-sixth of the proceeds from the land sales for this improvement (Wisconsin, State

of [Laws] 1848- [1852: 690]). In 1852, improvement included the construction of nine wing dams and removal of overhanging trees along a small portion of the river (Schaffer 1937: 102-03; Sanborn 1900: 189; U.S. ACE [Report] 1839-1963 [serial 1744, H. Doc. 1, pt. 1, 1876: 211-12]; Mermin 1968: 28, 31; Green Bay and Mississippi Canal Company 1848-1909 [Board of Public Works, vols. 1-2]; Vogel 1993: 33-39).

The board hired C.M. Kingsbury to act as lock tender and collector at Portage City on April 27, 1853. He supervised the operation of the locks and collected tolls for the transportation of lumber and other goods through the canal according to the schedule adopted by the board on May 9, 1851. Although the full waterway remained incomplete, the minutes of the board noted limited use of the west end of the improvement by steamboats and durham boats in 1853 (Green Bay and Mississippi Canal Company 1848-1909 [Board of Public Works, 1848-53, vols. 2]).

Construction costs chronically exceeded income from land sales. Land sales yielded sufficient funds to operate within the stipulations of Congress through January, 1851. By the third year, the number of land sales began to decline. To finish the remaining construction, the board and governor executed an agreement with Morgan Martin, an advocate of the waterway, to complete the works between Green Bay and Lake Winnebago between 1851 and June 1853. He agreed to accept the state's certificates of credit for the cost when land sales did not offer sufficient funds to provide payment. The board also extended this credit to other contractors at an interest of 12 percent (Schaffer 1937: 104; Martin 1851).

This approach to funding the improvement was contrary to the intent of the restrictions established by the land grant. While the state constitution prohibited the accumulation of a debt of any amount for internal improvements, it did permit its representatives to pledge income from the sale of public lands (Schaffer 1937: 104). Although the move was technically constitutional, the new whig governor, Farwell, who probably sought the completion of the Rock River improvement rather than the Fox-Wisconsin Waterway, delayed the issue of scrip until Martin in 1852. This move slowed the completion of the work outlined by the board until the legislature overruled the governor's actions. In addition, the legislature authorized the use of stock certificates at 12 percent interest. They were used to pay contractors or augment funds through their sale. Repayment of the certificates and scrip could occur only through land sales and was backed only by potential revenues from the improvement. The board's source of needed funds lay in additional land grants from Congress. The faith that Congress would ultimately provide such support was characteristic of the return of the speculative mood of the early 1850s.

As work on the improvement proceeded, the debt in the form of scrip and certificates against the land sales mounted. The value of the state's credit declined. At the end of 1853, the cost of the debt and the completion of the project had risen to \$502,574 above the amount already received from the sale of lands. The total amount was equivalent to twice the sum estimated in Cram's 1839 report, the approximate figure used by the board to estimate the original cost of the project. Since primarily marginal lands remained unsold from the land

grant, this source provided insufficient revenue to cover the growing debt (Schaffer 1937: 103-105; Sanborn 1900: 190-91; Smith 1973: 455; Wisconsin Division of Historic Preservation n.d. [memo from Richard W. Henneger, 3/31/76]; Meindl 1991: 11, 19, 37; Mermin 1968: 28-9; River Times 1851 [7/20: 1-2/1]; Martin 1888: 411-12).

As the debt rose, the legislature conducted investigations of the Board of Public Works in 1852 and 1853. They found that the board committed errors in improvement locations and engineering. The investigators accepted the limited experience with such projects in Wisconsin. They remained unable to find evidence of clear corruption or impropriety. Contracts proved favorable to the interests of the state rather than the contractors or the interests of individual board members. However, the investigation did find that the issuance of scrip and certificates might eventually result in contracting an unconstitutional state debt. Court rulings in the early 1850s found that they acted within the limits of the state constitution since the granted lands and revenue from the improvement were being used as the basis for issuing the scrip and certificates. The favored means of resolving the debt became the disposition of the improvement to a private, bonded enterprise (Mermin 1968: 39, 44, 59-60).

The Wisconsin Board of Public Works failed to complete the construction primarily because the land sales provided insufficient revenue to cover the costs of the improvement. Intended as an added safeguard, the inordinately slow process of land selection, approval, and transfer to the state from the federal government prior to marketing failed to supply a sufficient amount of land for sale in a timely fashion at the beginning of the project. Later, the lands, a significant portion of which were agriculturally marginal wetlands, did not sell. In addition, the pacing of land sales with construction slowed land sales, eventually resulting in the use of the credit system based on their sale to pay contractors. Thus, many of the legal restrictions of the grant, the insufficient amount of saleable land, and the state's refusal to sustain a debt primarily created to the financial plight of the improvement (Mermin 1968: 25-26, 60).

The improvement of the Fox-Wisconsin Waterway in many ways reflected earlier projects. The congressional act which supported the project with a land grant specified state management of the project. A state board had become the typical mechanism to guide such projects. Private enterprise did not usually undertake such improvements because it lacked sufficient capital to support them. Since the waterway provided public access to trade, a concern existed that private promoters would fail to serve the public interest. Despite the constitutional prohibition of contracting a state debt as Wisconsin's neighbors had through the sale of bonds, the quasi-unconstitutional issue of scrip and certificates based on the sale of lands eventually forced the state to transfer the improvement to private hands. This response had been one popular solution to relieving state indebtedness during the late 1830s and early 1840s. The undertaking of such a project by a new state with limited population and capital even in the 1850s was a financial and engineering challenge which was not easily met.

The Fox and Wisconsin Improvement Company: 1853-66

To continue construction of the improvement, the legislature chose to convey the responsibility for its completion to a private company. The agreement specified that the state would not be liable for debts or incomplete work and that the company would repay all indebtedness accumulated during the construction of the project by the state. The company would benefit through the operation of the improvement and from the sale of the remaining lands. This transfer was supported by a convention in Oshkosh in the May 1853 (Schaffer 1937: 106; Vogel 1993: 40; River Times 1853 [2/21: 2/1-2]). The Wisconsin legislature incorporated the Fox and Wisconsin Improvement Company on July 6, 1853, under Chapter 98 of the Laws of Wisconsin.

The 1853 act also specified the terms under which the company would receive the improvement. The state provided to the company all its unsold lands, claims in its improvements, plats, maps, and papers so that it became the state's successor in title to the improvement and its lands (East Central Wisconsin Regional Planning Commission 1948-85 [letter, 2/4/48 from R.A. Wheeler, Chief of Engineers Office]). The act retained the original land grant's qualification of government use of the waterway without charge. It also specified free use of the main channel for the public. This provision excluded the locks. Each member of the company posted bond with the secretary of state. The agreement required completion of the waterway improvements by 1856, and the state retained the right to repurchase the structure within twenty years (Vogel 1993: 41).

Established on June 1, 1853, well before the July act, the company included eight members who came from the Green Bay to Fond du Lac area. Mason Darling initially served as its president. However, Morgan L. Martin provided the company's primary leadership. Martin migrated west to Wisconsin from New York in 1827. As delegate to Congress in 1846, he had obtained passage of the original act which provided the land grant. Martin served as the president of the second state constitutional convention held in 1847. He had contracted with the State Board of Public Works to complete a portion of the improvement in 1851 and 1852. In 1855, Martin agreed to build an unknown portion of the improvement for the private company. Additional officers of the company included Otto Tank, its vice president; Joseph Lawton, secretary; and Edgar Conklin, treasurer. J. Kip Anderson served as the company's first engineer. By 1856, Daniel C. Jenne supervised work along the Fox River, and D.C. Isaac appears to have overseen work along the Portage Canal and inspection of the Wisconsin River. Resigning in 1860, Jenne became a division engineer for the New York canal system by 1863. George McDonald served as his replacement between at least 1860 and 1862. C.D. Westbrook, also an engineer, represented the interests of the eastern capitalists in the improvement. He inspected the waterway late in 1854 (Smith 1967; 1954: 69; Schaffer 1937: 106, 128; Martin 1888: 408, 412; Green Bay and Mississippi Canal Company 1848-1909 [vol. 3, Fox and Wisconsin Improvement Company 1853-66, 1862 report]; U.S. ACE [Report] 1839-1963 [serial 1173, H. Doc. 55, 1863: 3]; Mermin 1967: 55-57).

Since the original land grant failed to provide sufficient funds to complete the improvement, the company sought other sources of revenue early in its operation.

In addition to the lands it received, the company began the sale of bonds to pay the state debt and support the improvement of the waterway. Setting a rate by September 1853, the company intended from the beginning to lease the waterpower along the waterway. By October 1859, it had begun to develop the waterpower created by the navigation dams along the Lower Fox River. It also erected warehouses along the waterway for storage of goods shipped by the company and for leasing to other enterprises, constructed barges, and negotiated with steamships to ship goods. Realizing its shortage of funds from the outset, the company raised a mortgage of \$500,000 in bonds secured against the company's property. Isaac Seymour and William Averill of New York City became the trustees for the bond holders. Between 1853 and 1855, members of the company including Martin and Otto Tank experienced continual problems in selling the bonds. The market had become flooded with bonds for improvements and other investments.

In 1854, C.D. Westbrook, engineer of Kingston, New York, inspected the improvement for these investors. His conclusions about the low amount of work necessary to make the Wisconsin River navigable, the limited threat of railroad competition to the waterway, the high value of both the waterpower and tolls, and the growth of future commerce painted an overly optimistic picture of the situation. He found that the Portage Canal had been completed. However, Westbrook doubted the longevity of the locks and found that sand washed into the canal from the Wisconsin River and from the banks of the canal itself. He also noted that the works along the lower Fox River remained incomplete. But, Westbrook believed these improvements could be completed by the end of the following year (Schaffer 1967: 106-109; Mermin 1968: 61-74).

The Fox and Wisconsin Improvement Company completed significant improvements along both the upper and lower Fox River. Beginning in the fall of 1853 and continuing through 1855, it resumed construction at the locations along the lower Fox River where original projects remained incomplete: Winnebago Rapids, Grand Chute, Kaukauna, Cedar Rapids, Little Chute, and Menasha. In the summer of 1855, the company brought a large number of laborers and carpenters from Buffalo, Chicago, and Milwaukee to expedite the work. Defects in construction of the locks continued to slow the company's progress. By the close of 1855, work totaling \$32,389 remained, principally represented by the excavation of the Little Chute channel. The dredge boat operated along the Upper Fox River during at least 1854 and 1855. The company also began to improve the Upper Fox by the creation of a slack water system. It erected the Governor Bend lock and dam structures, the one closest to the Portage Canal (figure 3), between 1863 and 1865. The lock provided a lift which exceeded 3' and originally measured 35' x 160'. It was built as a composite structure with walls of unmortared, stone-filled, timber cribs and sheathing of wood planks. An unknown level of work had begun on the Montello Lock by July 1858. In 1857, Daniel C. Jenne, the company's engineer, inspected the Wisconsin River between Prairie du Chien and Portage. He concluded that a channel of 6' to 7' could be attained. The Fox and Wisconsin Improvement Company did not complete improvements along the Wisconsin during this period (Schaffer 1937: 128; Smith 1967; Vogel 1993: 42-43; Meindl 1991: 23-24; Green Bay and Mississippi Canal Company 1848-1909 [vol. 3, Fox and Wisconsin Improvement Company 1853-66]; Wisconsin Governor 1840-1914 [1854-62, folder 1, box 10, 1854-55 reports of the Fox and Wisconsin Improvement Company]).

When the legislature extended the completion date of the improvements in 1856, it specified reconstruction of the locks at Portage and the enlargement of the canal so that boats could pass each other. All improvements were to reach completion by November 1858, and the dredging was to be finished by November 1859 (Wisconsin, State of [Laws] 1848- [1856, chapter 112]). After the completion of its construction in 1851, the Portage Lock underwent few additional improvements during the 1850s and 1860s. It did receive some repairs in 1858. In 1867, G.K. Warren of the Army Corps noted that this lock remained in dilapidated condition. The company conducted a large amount of dredging along the canal in 1858 and 1859 so that boats could pass from the Wisconsin to the Upper Fox River. However, Warren later observed that the canal varied from 5' at the Fort Winnebago Lock to 18" in depth at the Portage Lock. He explained that the mill at the east end tended to draw down the water (figure 8).

At the Fort Winnebago Lock, the company may have replaced the east gates in 1856. Work continued on the lock in 1857 and 1858. In May 1858, the minutes of the company noted that the contract with Nelson McNeal and Morris Mitchell to replace the Fort Winnebago Lock between November 27, 1856, and May 1, 1857, remained incomplete. This contract was canceled, and the engineer was instructed to find another firm. The rebuilding of the lock reached completion in 1859. It was constructed on the site of the first lock, and placed 5' lower to provide adequate depth for navigation. It provided a lift of 7'. Composed of stone-filled timber cribs and masonry head walls, this lock measured 35' x 160' (Meindl 1991: 27-28; Fox and Wisconsin Improvement Company 1859-62 [1862: 6, 9]; Green Bay and Mississippi Canal Company 1848-1909 [vol. 3, Fox and Wisconsin Improvement Company 1853-66]; U.S. ACE [Report] 1839-1963 [serial 1278, S. Doc. 16, 1867: 18; serial 1744, H. Doc. 1, pt. 2, 1877: 224-26]¹⁰).

By 1856, the level of improvement and a period of high water allowed the steamboat Aquila, built in Pittsburgh, to travel the waterway from Pittsburgh, down the Ohio River, up the Mississippi, and along the Fox-Wisconsin Waterway to Green Bay (Martin 1888: 413). However, although steamboats navigated the Fox River between Green Bay and Berlin with some regularity by 1856, use of the Upper Fox River above Berlin was primarily confined to lumbermen with flat bottom boats or travel at its extreme west end. Even the lumbermen divided their load to decrease their draft within several miles of the canal. Low water halted navigation along the Lower Fox River in late July 1856. Although the waterway opened on an annual basis in the spring, its shallow depth at low water frequently closed navigation as the year progressed. The tolls generated at the locks and hence the volume of traffic remained insufficient to support the costly maintenance of the canal and expand its capacity. Since tolls were charged only at the locks, much traffic could use the improvement without payment. A sufficient volume of navigation to produce this needed revenue required an increase in project depth to handle greater tonnage and provide a more reliable facility less subjected to fluctuations in precipitation (Fox and Wisconsin Improvement Company 1859-62 [1862: 4]; Vogel 1993: 41-43).

¹⁰ This information is taken from G.K. Warren's report of 1877.

Thus, although steamboats navigated the waterway particularly during period of high water, the Fox and Wisconsin River Improvement Company lacked the resources to expand its capacity. During its first two years of existence, the company had failed to raise sufficient funds from its land grant and sale of bonds to complete the improvement. By the mid-1850s, capital had become increasingly tight as the depression in the later part of the 1850s neared. Martin found it more and more difficult to sell lands and company stocks or borrow funding. Investors tended to put their limited capital into railroads rather than waterways. By the end of 1855, the company began to reduce the amount of improvement work, focusing increasingly on repairs or the completion of projects already begun (Schaffer 1937: 112-16; Green Bay and Mississippi Canal Company 1848-1909 [vol. 3, Fox and Wisconsin Improvement Company, 1853-66]; Wisconsin Governor 1840-1914 [1854-62: folder 1, box 10, 1854 and 1855 reports of Fox and Wisconsin Improvement Company]).

To secure further support, the company pressed for additions to the land grant of 1846. In 1854 and 1855, it sought re-interpretation of the terms of the original land grant. The federal government based contemporary grants such as the one to the Wabash and Erie Canal in Indiana on the absolute mileage of the river and granted alternate sections along a five mile width on either side of the river. The 1846 land grant had provided three alternate sections on either side of the river. Failing to calculate the absolute length of the Fox River, the Oshkosh land office had not included the meanders of the Upper Fox River in its computation of the mileage on which the grant was originally based. The acts of 1854 and 1855 amended the original land grant to include the absolute length of the Fox and a five mile width. These acts provided an additional 100,000 acres in 1854 and 268,000 acres in 1855. The act of 1854 also provided to the state the remainder of the lands granted in 1848, principally the lands compensating for those already disposed of by the federal government prior to 1848. Including these later additions to the land grant in 1854 and 1855, the grant totalled 700,000 acres. Although the additions to the grant were secured by the considerable lobbying of company representatives, Congress provided these lands to the state rather than directly to the company (Schaffer 1937: 112-16, 120-21; Sanborn 1900: 191; Mermin 1968: 61-71). Also, under chapter 64 of the general laws of 1855, the legislature authorized an increase of capital stock of the company to \$250,000 (Martin 1888: 413).

In June 1855, the company also secured a loan of \$160,000 from Horatio Seymour, Erastus Corning, and Hiram Barney all of New York. The circumstances of the loan which were highly favorable to the eastern capitalist resulted in their direct operation of the company. In that year, Erastus Corning, the Albany railroad financier for the Grand Central, politician, and industrialist, became president of the company. Martin served as its vice president and the primary manager of its affairs. The involvement of eastern financiers in the construction of midwestern railroads in the 1850 had become a common means to provide funding in newly settled areas chronically short of capital.

After receipt of additional lands placing its assets well above the amount believed necessary to complete the work under the current plan, the state legislature requested an investigation of the company in 1856. The company's

inability to meet payments on state indebtedness, complete the improvements within the allotted deadlines, and maintain the condition of the improvement as well as its recent measures to borrow capital had eroded public confidence in the company.

After its investigations, the legislature permitted the company to continue and provided it with the additional lands secured from the federal government. However, on October 3, 1856, in its chapter 112 of the laws of 1856, the legislature required enlargement of the original improvement within three years (Wisconsin, State of [Laws] 1848- [1856: 123-31]). Based on plans drawn by the company's engineer, Daniel C. Jenne, it specified that the canal accommodate boats at a low water draft of 4' between Green Bay and Lake Winnebago and 3.5' draft between Lake Winnebago and the Wisconsin River. The waterway was to accommodate a minimum vessel size of 33' x 140'. The act required the reconstruction of certain locks including the two at Portage to achieve compatible size and quality and type of construction for all of the locks. Although the object of the improvement was to connect the Great Lakes with the Mississippi for steamboat navigation, the agreement did not require improvements along the Wisconsin River. The company and other advocates of the waterway soon looked to the federal government for financial and construction assistance for this section of the waterway. Completion of the Fox and Wisconsin improvements was soon to be viewed as two separate projects.

The 1856 act also required that all state indebtedness already due be paid within six months and the remaining notes receive payment when due. The state reserved the right to acquire the improvements within twenty years and disclaimed any liability for the company's indebtedness. Finally, the legislature required the company to execute a deed of trust transferring all unsold lands of the grant, the improvements, and rights in any additional property to a board of three trustees. Although this move in a sense provided a watchdog for the company, it also gave it a semi-public facade and provided more financial credibility (Schaffer 1937: 117-18; Green Bay and Mississippi Canal Company 1848-1909 [vol. 3, Fox and Wisconsin Improvement Company 1853-66]; Mermin 1968: 80-87; Wisconsin, State of [Journal of Proceedings] 1848- [1857: 23-24]).

With the additional funding, the company did develop plans to increase the depth of the waterway. Contractors were retained to complete the work. The Fort Winnebago Lock was completed in 1859 as noted. Even though George Paddock was to perform work at the Portage Lock, it was probably never done. The panic of 1857 halted much of this work (Mermin 1868: 75; Vogel 1993: 42-43; Green Bay and Mississippi Canal Company 1848-1909 [vol. 3, Fox and Wisconsin Improvement Company 1853-66]; Drago 1972: 213).

As the company struggled to complete the Portage Canal and Fox Waterway in December 1856 or early 1857, the LaCrosse and Milwaukee Railroad bridged the canal just north of the current STH 33 bridge over the canal. Stone abutments remain visible at the site. The railroad began to operate between Milwaukee and Portage in the spring of 1857, and it reached LaCrosse in 1858. Through a series of reorganizations, this line became the Milwaukee and St. Paul Railroad in 1863. This bridge and its associated line known as the Old Line were abandoned in 1907

and later removed. In 1864, the Milwaukee and St. Paul also purchased sufficient trackage with the addition of twenty-eight miles to operate a line through Brookfield known as the Air Line. It essentially paralleled the eastern division of the LaCrosse and Milwaukee, the one built through Horicon in 1856 and 1857 which then became known as the Old Line or Northern Division. The Air Line entered Portage from the southeast along the current trackage. A second railroad bridge spanned the canal just south of Center Street at the site of the current tracks by 1868. By this date, both structures were iron lift bridges (Rugen 1868; Ligowski 1861; Portage Library n.d., 1909-10 [photograph of lift bridge]; Raney 1940: 184-85; Chicago, Milwaukee and St. Paul ca. 1944; Scribbins 1987a: 19-21; Sutterfield 1880: 485-89; Jones 1914 [1]: 100-101; Wisconsin State Register 1863 [8/17: 3/1]).

Since eastern capitalists provided the financial backing, they dominated the fiscal operations of the company by the mid-1850s. The movement to organize a new company began in 1860. Through chapter 289 of its acts of 1861, the legislature authorized the sale of the Fox and Wisconsin Improvement Company and the formation of a new corporation by the purchasing agent. However the Civil War intervened. Perhaps as an interim measure, the legislature extended the completion date of the work and the payment of state indebtedness from 1859 to 1863 and then to 1864. It was not until 1863 that the trustees began proceedings to sell the company because it failed to meet the requirements of the 1856 act and later amendments. Thus, the private company, like the State Board of Public Work, proved unable to accumulate sufficient financing to complete the improvement according to the contemporary project description for the waterway (Schaffer 1937: 125; Martin 1888: 413; East Central Wisconsin Regional Planning Commission 1948-85 [letter, 2/4/48 from R.A. Wheeler, Chief of Engineers Office]; Green Bay and Mississippi Canal Company 1848-1909 [vol. 3, Fox and Wisconsin Improvement Company 1853-66]; Wisconsin, State of [Journal of Proceedings] 1848- [1863: 21]; Mermin 1968: 91).

In 1863, Captain T.J. Cram of the Army Corps of Engineers reported to the House of Representatives on the feasibility and cost of improving both the Fox and the Wisconsin rivers to attain a 6' channel, a depth sufficient to navigate gunboats. The purported concern was that Great Britain would assist the South against the Union, and the military might then require access into the interior. Cram noted the feasibility of the project stating that the Fox and Wisconsin Improvement Company had worked to complete the improvement according to the 1856 specifications of the legislature, the 3.5' to 4' navigation channel and 35' x 160' locks, until 1859. The company had achieved the required depth at some locations, and portions of the waterway were then in operation. Cram provided recommendations to achieve the 6' channel. He based the need for the improvement on military reasons thus permitting the Army Corps of Engineers to become involved in such a project. The 1863 journal of the Wisconsin Senate noted the federal government's consideration of the 6' channel improvement and encouraged promotion of the project by representatives in Congress. In his 1863 report, Cram suggested the waterway's improvement with assistance from the federal government (U.S. ACE [Report] 1839-1963 [serial 1173, H. Doc. 55, 1863: 1-5]; Wisconsin, State of [Journal of Proceedings] 1848- [1863: 10-11]).

The Green Bay and Mississippi Canal Company: 1866-72

The Fox and Wisconsin Improvement Company underwent foreclosure on February 2, 1866, at Appleton. On April 12, 1866, the state agreed in chapter 572 of its acts to the sale of the improvement. A nine-member group some of whom had been active in the earlier company purchased the improvement together as individuals for \$191,000. It then reorganized the company. Erastus Corning, Horatio Seymour, and Samuel Marsh, its president, were among them. The purchase cost covered the state debts and the improvements, waterpower, and land remaining to the improvement company. The state debt was paid prior to the conveyance of the improvement. On August 15, 1866, the individual purchasers filed articles of incorporation for the Green Bay and Mississippi Canal Company which then acquired the assets of the former company. The state trustees executed a deed of sale to the new company on August 16, 1866. For lands included in Columbia County, the transferred lands were recorded in volume 72, deeds, page 391 (East Central Wisconsin Regional Planning Commission 1948-85 [letter, 2/4/48 from R.A. Wheeler, Chief of Engineers Office]; Schaffer 1937: 125; Martin 1888: 413; Smith 1967; Fox and Wisconsin Improvement Company 1866; Green Bay and Mississippi Canal Company 186; Mermin 1968: 95, 97-98).

The act noted that the federal government had specified 1868 as the completion date of the improvement (Wisconsin, State of [Laws] 1848- [1866: 1404-1406]). The powers granted by the April 1866 state act included the ability to enlarge the improvement to the specifications of the 1856 act providing for a uniform navigation depth between the Great Lakes and the Mississippi, to accept further land grants particularly one involving the lands along the Wisconsin River, and to sell the improvement to the United States (Mermin 1968: 98).

Although the improvement had passed through several hands, the federal government had provided the initial land grant which included the completion date of the improvement. To meet the deadline set for the completion of the improvement, the canal company required the extension of the 1868 date granted by Congress to 1873. Such a request required inspection of the improvement. In 1866, Captain Charles R. Suter of the Army Corps of Engineers conducted a survey of the waterway for General Gouverneur K. Warren at St. Paul. Suter's report dated to 1867. Nathaniel M. Edwards, engineer for the canal company, assisted the examination. The report provided estimates to establish a 4' and a 6' depth. Suter described the Lower Fox River portion of the waterway as a slack water navigation system of locks and dams. The waterway had the capacity of carrying boats with a 3.5' draft at low water. Modifications were required at all existing improvements on the Lower Fox which then included eight project locations to achieve the proposed depth. Except for the lock at Rapide Croche, all locks were composite structures. Along the Upper Fox River, improvement of the meanders along the channel by dredging cut-offs totaling 18,000' shortened the improvement by about three-fifths of the original distance.

Suter noted that the improvement companies had conducted a large amount of dredging along the Upper Fox River with only limited effect. The depth of the Upper Fox was quite variable, and sand bars tended to reduce the depth of the Upper Fox to 3' to 3.5' at scattered locations. Sand bars filled the channel

within a mile of the Fort Winnebago lock so that the depth reach down to 2.5'. He found that a slack water system which was partially established by the Governor Bend lock and dam was the only method of creating a stable channel at the required depth. Suter defined six levels or pools of navigation for the Upper Fox. The 1859 Fort Winnebago lock had a depth of 6' above the lower miter sill and a lift of 7'. At the time of the survey, the Portage Canal, measuring 12,400' x 75', was quite shallow, decreasing from 5' at the Fox or lower end to 18" at the Wisconsin River end. The mill adjacent to the Fort Winnebago Lock tended to draw the water in the canal down 1'. By 1866, the Portage guard lock had become very dilapidated and required rebuilding. At the time of the report, sand filled the base of the lock, and it was undergoing dredging (U.S. ACE [Report] 1839-63 [serial 1744, H. Doc. 1, pt. 2, 1877: 230-38; serial 1278, S. Doc. 16, 1867: 15, 18-22; serial 1292, H. Doc. 58, 1867: 73-91; serial 1368, H. Doc. 1, pt. 2, 1868: 350-52]; United States [Statutes] 1867-58 [vol. 15, Res. No. 2, 1869: 20]).

Because the new canal company found little profit in operating the waterway for navigation purposes, it undertook only a small number of improvements during its oversight of the project. Instead of developing the navigation system, the Green Bay and Mississippi Canal Company quickly turned to the development of waterpower. The company not only leased the waterpower but constructed facilities to generate the waterpower at many of its dams. It continued to collect tolls for the passage of boats through the locks.

The company instructed Edwards to prepare plans and advertise for proposals for the extension and repair of the Portage and De Pere locks. While the company did rebuild the De Pere lock in 1869, the Portage Lock probably did not undergo repair. In late 1866, Edwards operated a dredge to clear the Portage Canal and the Portage Lock of sand and remove sand bars from the Upper Fox between Fort Winnebago and Lake Puckaway. Significant improvements along the upper river were probably limited to the construction of the Montello Lock and timber crib dam in 1868. Minor work at the lock was started by the Fox and Wisconsin Improvement Company in 1856 and 1857. The 1868 construction of the 35' x 160' lock is unclear. While its wing walls were composed of timber cribs, cut sandstone blocks formed the lock walls. References to planking along the walls suggests a composite structure. Additional work along the lower river included the clearing of the Menasha channel to achieve a 4' navigation depth at low water. A survey of the entire waterway conducted in 1872 found eighteen locks, nine dams, and eight canals along the Lower Fox (Schaffer 1937: 129-130; Meindl 1991: 30-31; Syllesty, H.M. & Company 1926: 4; Sanborn 1900: 192; Green Bay and Mississippi Canal Company 1848-1909 [vol. 4, 9/26/1866]; Vogel 1993: 48; Larson 1979: 177).

Major Suter also completed a survey of the Wisconsin River in 1866 to determine the level of improvement necessary for navigation. The survey extended from the Wisconsin Dells to the mouth of the river. It examined the physical features of the river: the depth of the river, its geology, the nature of its bottom and banks, and the location, depth, and size of sand bars as well as the volume and velocity of the river. Suter proposed the improvement of the Wisconsin to a 6' depth by use of brush and stone wing dams to narrow the channel. However,

General Warren doubted that such depth could be achieved using wing dams. In his 1868 interim report, Warren noted the failure of the 1852 wing dam system to maintain a river channel. Additionally, the narrow clearance left under seven bridges erected across the Wisconsin River required attention.

Based on the 1868 survey conducted by Captain Wellman, Warren provided three alternatives for achievement of a 4' or 6' deep navigation channel along the Wisconsin River. A combination of wing dams and dredging directly along the major sand bars provided the least expensive alternative. Secondly, he proposed improving a 4' channel along the existing river channel where it permitted and also utilizing old river beds and side canals along shallow parts of the river. The river's tendency to shift its channel considerably raised the cost of maintenance for this alternative. Finally, he believed that the excavation of a canal along the edge of the river and crossing the river at three points and would be the most successful but also the most costly. This alternative included twenty-one locks. In 1867, Congress appropriated \$40,000 to begin improvements along the Wisconsin River. Concerned with the expense of the third alternative, Warren recommended testing the wing dam approach to deepening the channel in a small portion of the river. Inspired by Warren's report, the 1868 Prairie du Chien convention memorialized Congress for improvements of navigation along the Upper Mississippi River as well as the Wisconsin River. Concerned about the high cost of shipping the wheat crop by rail and the capacity of the existing facilities, the Wisconsin legislature memorialized Congress on the same subject in 1869 and 1870.

In 1868, Major H.C. Long under Warren's direction began to test the feasibility of lowering sand bars in the Wisconsin River. With the steamer C.J. Caffrey, he attempted to scrap the bars from the mouth of the river. Extensive sand flats which closed its mouth ended the operation. In 1869, General Warren conducted the improvement of the Wisconsin River between Portage and Sauk City by pulling snags and leaning trees from the river with the government boat known as the Winneconne. This effort enabled two small stern-wheel ships to travel between the two points. Thus, by 1868, the federal government began limited improvements along the river. This work ceased in 1869 until an agreement was reached concerning the sale of the Fox River improvements (Fairchild 1869; Schaffer 1937: 129-130; U.S. ACE [Report] 1839-1963 [serial 1278, S. Doc. 16, 1867: 15, 26-27; serial 1368, H. Doc. 1, pt. 2, 1868: 51-52, 357, 368; serial 1413, H. Doc. 1, pt. 2, 1869: 187, 190-91, 202-04; serial 1744, H. Doc. 1, pt. 1, vol. 2, pt. 2, 1876: 242-56]; Larson 1979: 172-73; Mermin 1968: 103-07).

Because the Green Bay and Mississippi Canal Company failed to secure a land grant for the improvement of the Wisconsin, it never attempted to improve the river. In a July 7, 1870 act, Congress authorized the Secretary of War to adopt the improvement plan for the Wisconsin River recommended by the Chief of Engineers (United States [Statutes] 1867-1958 [vol. 16, chapter 210, 1870: 189-90]). An act of July 10, 1870, appropriated \$100,000 for this improvement. Expenditure of funds on either the Wisconsin or Fox river awaited the disposition of the Fox-Wisconsin Waterway. As Philetus Sawyer noted, this requirement of the act placed a considerable burden on the canal company to negotiate the conveyance of the improvement (Schaffer 1937: 131; U.S. ACE [Report] 1839-1963 [serial 1598, H.

Ooc. 1, pt. 2, 1874: 218]; Wisconsin Governor 1840-1914 [1871-79, file 3, box 10, letter from Philetus Sawyer).

Influential Wisconsin politicians including Governor Lucius Fairchild, Congressman Philetus Sawyer, and Senator Timothy Howe pressed for the purchase of the waterway by the federal government. Through its act of July 7, 1870, Congress directed the Secretary of War to assess the company's property including the navigation and waterpower improvements and its personal property. Considerable disagreement concerning the worth of the improvement arose between the Green Bay and Mississippi Canal Company and the War Department. To determine the amount due to the Green Bay and Mississippi Canal Company for its improvement, the Army Corps completed an evaluation of the property in 1871. In March 1871, both parties agreed to the arbitration specified by Congress. Improvement along the Wisconsin River by the Army Corps of Engineers began again when the decision to arbitrate the matter was reached in March 1871.

The company and Army Corps appointed a board of three arbitrators. The board included William Larrabee, later governor of Iowa, to represent the Secretary of War; J.R. Ooolittle of Wisconsin to present the company's interests; and Paul Oillingham of Vermont selected by the first two arbitrators. Realization that the improvement would not provide an efficient navigation channel between the Mississippi and the Great Lakes without its completion made evaluation of its worth extremely difficult. The board finally determined a total value of \$868,070. This figure included the cost required to build a facility of that size less its depreciation. The board then deducted from it those items unnecessary to the improvement of navigation. This property included the rights to 2,000 horsepower created by the waterpower rights. This figure included fifty horse power at Portage. The amount gained from the sale of lands granted by Congress; the unsold property; and personal property of the company were also deducted, giving a total of \$145,000. The board presented its report explaining the amount due to the canal company on November 15, 1871.

The Secretary of War concurred with the conclusions of the arbitrators and transmitted this recommendation to Congress on March 8, 1872. Congress approved the determination on June 10, 1872, and provided \$145,000 for the purchase of the navigation improvement. The company transferred the improvement to the federal government on September 18, 1872. For the property in Columbia County, this transfer was recorded as volume 57, deed page 403 (East Central Wisconsin Regional Planning Commission 1948-85 [2/4/1948 letter from R.A. Wheeler, Chief of Engineers]; Meindl 1991: 21, 26-28; Martin 1888: 413; U.S. ACE [Report] 1839-1963 [serial 1513, H. Doc. 185, 1872: 1-7, 12¹¹; serial 1598, H. Ooc. 1, pt. 2, 1874: 218-20, 224-25]; Wisconsin Governor 1840-1914 [file 3, box 10 [1869-70 and 1871-79, letters from Secretary of War Belknap]; Green Bay and Mississippi Canal Company 1872; Hooper 1920; Mermin 1968: 117-25, 129-33).

¹¹ This serial contains the reports of the board of arbitrators appointed to determine the amount Congress was to appropriate as the purchase price of the improvement from the Green Bay and Mississippi Canal Company.

The facilities transferred to the federal government included twenty-two locks, eleven dams, and 7.5 miles of canal. The Green Bay and Mississippi Canal Company did retain all rights to waterpower in excess of the amount necessary for navigation at both its own dams and the government dams, to the lands unassociated with navigation and necessary to maintain and develop that waterpower, and to its personal property. The exact definition of what the federal government purchased continued to be the object of periodic investigation well into the twentieth century (U.S. ACE [Report] 1839-1963 [serial 3691; H. Doc. 389, 1898: 2341-43, 2353, 2358, 2373-74, 2380]; Day and Zimmermann 1928 [report]: 10; Green Bay and Mississippi Canal Company 1877: 8-9; Byllesty, H.M. & Company 1926: 4-5, 18-19, 39; Bridwell 1983; Kleist 1985: 15).

The existence of the Green Bay and Mississippi Canal Company did not cease at the sale of the improvement. Rather than operating its holdings, the canal company secured revenue by leasing its waterpower rights, real estate, and plants to other interests. These joint interests shared by the federal government, the canal company, and private land owners continually caused litigation concerning water rights and damages to lands and improvements caused by flooding from the dams which began shortly after the transfer of the navigation improvements. On November 21, 1973, the Green Bay and Mississippi Canal Company sold all its assets including its real property, waterpower rights, buildings and structures, machinery and equipment, and leases to the City of Kaukauna. In this deed, the city received waterpower generated by the dams at Appleton, Little Chute, Combined Locks, Kaukauna, Rapid Croche, and Little Rapids for its municipal utility (Green Bay and Mississippi Canal Company 1973 [closing document]; 1877; ca. 1913; ca. 1893; Byllesty, H.M. & Company 1926: 5, 39; Day and Zimmermann 1928: 10, 15, 37; Whitbeck 1915: 32; Baer 1893; Green Bay and Mississippi Canal Company).

The Operation of the Fox-Wisconsin Waterway under the Army Corps of Engineers: 1872-1961

The Completion of the Improvements along the Fox River: 1872-80

Even before the 1872 transfer, the Army Corp had surveyed both the Fox and Wisconsin rivers and prepared reports on the approach to their improvement. In the early 1870s, there was much optimism about the rapid completion of the two projects and final achievement of the through-connection between the Great Lakes and the Mississippi River. The Wisconsin legislature and improvement conventions memorialized Congress annually in the late 1860s and early 1870s. Congressional response to this optimism resulted in comparatively large appropriations during the first several years of the waterway's federal operation. Congressman Philetus Sawyer used his growing influence to shepherd the river and harbor bills through the appropriate channels in the early 1870s. In 1870, the \$100,000 were appropriated for the improvement of the Wisconsin River. On June 10, 1872, Congress authorized \$145,000 in its rivers and harbor bill to purchase the Fox and Wisconsin Waterway from the Green Bay and Mississippi Canal Company. The appropriations for each of the years 1873 and 1874 totaled \$300,000 for the

repair, preservation, and completion of the waterway. In 1875, they peaked at \$500,000. Between 1878 and 1885, appropriations dropped considerably to approximately \$170,000 each year. As the attempts to improve the Wisconsin River continued to fail and operations became confined to the Fox River in 1886, funding descended to \$56,000 (Mermin 1868: 142-45; U.S. ACE [Report] 1839-1963 [serial 1559, H. Doc. 1, pt. 2, 1872: 35]).

Major Houston then stationed in Chicago guided the improvement of both the Wisconsin and Fox rivers. When the Army Corps began to work in earnest along the Fox-Wisconsin Waterway, it established three suboffices at Appleton, Oshkosh, and Portage. When he received the responsibility in 1872, Houston conducted a survey of both rivers in the same year to plan the approach to improvement and estimate the cost. The original project produced detailed planning for a 4' channel depth and locks measuring 35' x 160'. However, preliminary plans for channel depths of 5' and 6' were also prepared and any improvements using the 4' depth permitted expansion to the greater capacity. Houston projected the creation of a total of nineteen navigation pools from the natural head of navigation at De Pere to the level of the Portage Canal. Nine pools, seven on the Lower Fox and two on the Upper Fox, existed when the Corps began its inspection in 1872. Five dams and locks to create five additional pools were planned to establish a slack water system along the full length of the Upper Fox.

The lift locks along the lower Fox between Menasha and De Pere had been completed under previous contracts primarily between 1849 and 1856. To bring the Lower Fox to a depth of 4' and refurbish the system required dredging, removing boulders, replacing some of the lock gates, relining locks and repairing miter sills underneath the gates, building embankments, and raising the height and rebuilding of some of the dams. Planned by 1873, a 6' channel for the Lower Fox additionally entailed excavating through rock to deepen the channel adjacent to some of the locks, sinking the miter sills or raising the gates and walls of the locks, and further dredging the channel and raising the dams. As he became more familiar with the condition of the facilities by 1875, Houston concluded that nearly all of the locks and dams on the Lower Fox, the earliest works on the river to be constructed, required rebuilding (Larson 1979: 176-78; U.S. ACE [Report] 1839-1963 [serial 1598, H. Doc. 1, pt. 2, 1874: 212, 219-22, 225-26, 233-41; serial 1744, H. Doc. 1, pt. 2, 1877: 237-39]; Wisconsin Governor 1840-1914 [1880, folder 5, box 10, letter and report from Major D.C. Houston]; Vogel 1992: 90).

The initial reconstruction of the Fox-Wisconsin Waterway occurred between about 1874 and 1878 under the guidance of the Army Corps of Engineers. Despite the years of construction on portions of the Fox-Wisconsin Waterway, the Army Corps found improvements in poor condition and constructed so that they were unable to carry the large steamboats of the era. The waterway had undergone relatively little recent maintenance, and the permanency of many of the early structures was limited. The Army Corps continued the development of a hand-operated system designed for steamboats initially contemplated for the waterway in the late 1830s. While the Army Corps planned rebuilding of most of the eighteen locks and dams along the Lower Fox, its work during the mid-1870s was limited primarily to necessary repairs to keep the Lower Fox facilities operating. In 1880, Major

Houston reported that six new masonry locks replaced seven of the old locks and seven new dams, one was masonry and the remainder were crib and stone structures, replaced existing dams. The remaining locks were repaired although not rebuilt. The Army Corps had dredged the channel of the Lower Fox to provide a navigation depth of five feet at ordinary stage and worked along the canal at Appleton.

Initially, the focus of work by the Army Corps became the attainment of a stable 3' channel within a slack water system along the Upper Fox which was frequently unnavigable during periods of low water. The Army Corps attained such a channel at most points by 1880. By 1878, the Upper Fox contained seven lift locks and seven dams, excluding the lift and guard locks at Portage, to overcome the 39' fall between the Wisconsin River and Lake Winnebago. The private improvement companies had constructed those at Governor Bend and Montello, the two nearest the Portage Canal, in ca. 1864 and 1868 respectively. The Grand River, Princeton, White River, Berlin, and Eureka locks reached completion between 1874 and 1878. The locks constructed by the Army Corps measured 35' x 170' rather than the 160' length of the earlier locks. Limestone laid in cement and faced with ashlar stone composed the five more recent locks while the two earlier locks were rubble stone or cut stone sheathed with planking to achieve a water-tight structure. In 1877, short canals to the locks and brush and stone dams were constructed at four of the properties. The Army Corps also undertook an extensive dredging operation along the Upper Fox beginning in 1872. By 1877, it had achieved at least a 3' channel along much of this portion of the river. However, the continual formation of sandbars along the Upper Fox between Portage and Princeton progressively decreased the depth from 4.5' to 2.5' near the Fort Winnebago Lock. This section required intermittent dredging operations which the Army Corps continued until 1927. By the 1880s, the Army Corps was also dredging cut-offs across the sharpest bends which remained along the Upper Fox River.

The Army Corps itself conducted the improvements along the Upper Fox through the fall of 1874. After that date, it completed major projects exclusive of the dredging through contract. Although the agency proposed to dig a new lock basin and turning area in the narrow piece of land south of the west end of the Portage Canal, this reconstruction never occurred. The Army Corps intended to keep sand out of the entrance to the canal by reorienting the canal's mouth toward the southwest. Plans for this new route are shown as late as 1888 by Henry Merton, Civil Engineer (U.S. ACE, Chicago District n.d., 1873-1928 [tube 71/204, plan, east end of canal, 1888]). However, in 1879, the dredge did remove 15' from the south side of the canal probably east of the Portage Lock to provide turning space for boats. Begun in November 1874 and continuing into 1876, work in Portage included the dredging of the canal to create a structure 75' wide by 5' deep at low water. Over the years, portions of the canal had filled with sand. Prior to dredging, the depth in front of the Portage Lock measured 2'. The Army Corps completed the dredging with the assistance of a steam excavator. By 1880, the Army Corps described a 6' depth for the canal's channel.

The agency contracted with Conro, Starke & Co. of Milwaukee to complete the revetments along the canal between November 1874 and July 1876. The canal banks were reinforced where deteriorated with 7' high timber revetment walls. The Milwaukee District of the Army Corps prepared two similar plans for the

revetments in 1875 and a third in 1876 (figure 10; photograph WI-104-34). The 1875 plans showed a less substantial form of the design prepared in 1876 (U.S. ACE, Chicago District n.d., 1873-1928 [designs 13-H-5 and 13-H-6, tube 72/204, 1875 revetment plans]). In all three designs, the revetments are supported by posts placed in the bank well behind the revetment wall. It is assumed that the 1876 design superseded those prepared in 1875 for at least a portion of the revetment walls. The 1876 plan for the revetments illustrate 16' high pine piles driven into the side of the bank to expose 7' placed at 6' on center. The 12' long anchor piles were set deep in the bank and attached to the revetment piles with 9' long tie rods. Horizontal planking covered the back or bank side of the piles (U.S. ACE, Chicago District n.d., 1873-1928 [design 13-H-7A, tube 72/204, 1876 revetment plan]). In 1880, the Army Corps dredged the Wisconsin River entrance to the Portage Lock and placed wooden fenders along each side between the lock and the river. By 1884, the tops of the revetments already exhibited some signs of decay (U.S. ACE [Report] 1839-1963 [serial 1744, H. Doc. 1, part 2, 1877: 237, 412, 423; serial 1845, H. Doc. 1, vol. 2, pt. 2, 1879: 1536-37; serial 1955, H. Doc. 1, pt. 2, vol. 2, pt. 3, 1880: 1947-48, 1967-68; serial 2280, H. Doc. 1, pt. 2, vol. 2, pt. 3, 1885: 2038-39]).

The City of Portage replaced the bridge removed by the Army Corps from the Wisconsin Street crossing in 1879. The new draw bridge had an iron superstructure and stone abutments and provided a clear horizontal space of 50' for the passage of boats. A wood float bridge existed at this site by 1853, but it may have been replaced prior to this date (Wisconsin Governor 1840-1914 [1852-53: folder 8, box 9]). In 1880, the city erected an iron swing bridge with masonry substructure at the site of the Ketchum Point float bridge also erected in 1853. In 1873, N.M. Edwards, who worked under Major D.C. Houston, recommended the construction of a waste weir at the east end of the canal to handle excessive high water in the canal. E.C. Hinman suggested construction of a waste weir by taking the excess water through a pipe from the south side of the canal west of the Fort Winnebago Lock to the Fox River (U.S. ACE n.d., 1873-1928 [document 13-H-2, tube 72/204, letter from E.C. Hinman, 2/29/76]). The Army Corps erected or less likely replaced the waste weir at this site in 1876 according to plans drawn in the same year (see photograph WI-104-41 for location; figure 9).

The two locks at either end of the Portage Canal also received attention. Both locks continued to measure 35' x 160'. Reports continually referred to the dilapidated condition of the Portage Lock during the 1870s and noted that it required rebuilding. By 1873, the Army Corps repaired and removed sand from the timber lock. By 1877, the limited work at the lock included repairing the gates and replacing rotting timbers. In 1878, the west miter sills and gates and balance beams were repaired. In 1880, the lock received relatively extensive repairs. The upper timbers along the walls of the lock, the upper wing walls, hollow quoins, gates, and snubbing posts were replaced. Rack and pinion attachments for the gate hangings replaced the balance beams attached to the top of the gates. New planking relined the walls of the chamber. The lowering of the upper and lower miter sills increased the depth of water in the lock. The report indicated that a waste weir was constructed through the Portage Lock by adding openings near the top of the upper lock gates (U.S. ACE [Report] 1839-1963 [serial 1744, H. Doc. 1, part 2, 1877: 237, 412, 423; serial 1845, H. Doc. 1,

vol. 2, pt. 2, 1879: 1174, 1536-37; serial 1955, H. Doc. 1, pt. 2, vol. 2, pt. 3, 1880: 1947-48, 1967-68; serial 2280, H. Doc. 1, pt. 2, vol. 2, pt. 3, 1885: 1930, 2038-39]; U.S. ACE, Chicago District 1873-1928 [plan 13-H-2, tube 72/204, showing waste weir, 1876; plan 13-D-11, tube 71-204, showing the location of the proposed lock pit; plan 13-H-7A, tube 72-204, revetment, 1876, 1928]).

The Fort Winnebago Lock, a composite structure, was also extensively refurbished between 1874 and 1876. New cribbing replaced the old timber cribbing to the low water line along its walls, new planking was placed along the floor and sides of the lock, and the miter sills and hollow quoins and adjacent gates were replaced. The lock now provided a lift of 7'. It also underwent repair in 1878. The gates and valve levers received repair; leaking around the miter sills and walls was stopped; floor boards were secured; snubbing posts were placed along the top of the walls; and the north, upper wing wall was extended. The Army Corps conducted dredging along a sand bar east of the lock. In 1879, the lock also received minor repairs, primarily to the gate hardware and floor (Meindl 1991: 11, 21, 23-28, 35; Vogel 1993: 49-50; Butterfield 1880: 611-12, 690; Mermin 1968: 143-46).¹²

By the mid-1880s, the Army Corps had completed the slack water system, conducted considerable dredging along the Upper Fox, and rebuilt many of the locks and dams and dredged the canals along the Lower Fox. It renovated the Portage Lock, refurbished the Fort Winnebago Lock, and dredged the Portage Canal to a 5' depth and replaced the revetment along its sides. It had made the Fox portion of the waterway navigable for the local traffic which then operated along it.

Improvements along the Wisconsin River: 1871-86

Memorials written to Congress in the late 1860s through the 1870s not only supported the improvement of the Fox River but stressed the importance of the work along the Wisconsin River to establish a through-route to the Mississippi River (Fairchild 1869; U.S. ACE [Report] 1839-1963 [serial 2280, H. Doc. 1, pt. 2, vol. 2, pt. 3, 1883: 1922-24]). The future of the waterway depended on the improvement of the Wisconsin River to a depth sufficient to carry vessels navigating from the Mississippi River to the Great Lakes. Warren noted in his 1866 and 1877 reports that the ships or grain barges navigating the Mississippi were not suitable for shipping on the lakes. Thus, they would be required to break bulk before leaving the river system and entering the lakes. The capacity of the waterway needed to match that of the Upper Mississippi River (U.S. ACE [Report] 1839-1963 [serial 1744, H. Doc. 1, pt. 2, vol 2, pt. 2, 1877: 241]).

¹² Citations from the annual report of the U.S. Army Corps of Engineers: U.S. ACE [Report] 1839-1963 [serial 1598, H. Doc. 1, pt. 2, 1873: 242; serial 1636, H. Doc. 1, pt. 2, 1874: 42, 163; serial 1675, H. Doc. 1, pt. 2, 1875: 216, 220, 222-23; serial 1744, H. Doc. 1, pt. 2, 1877: 413; serial 1904, H. Doc. 1, pt. 2, 1879: 1532, 1536-38; serial 1955, H. Doc. No. 1, pt. 2, vol. 2, pt. 3, 1881: 1947-50, 1967-68]).

When the Board of Engineers finally concluded that the improvement of the Wisconsin River was not financially feasible in 1886, the Army Corps redefined the project for the Fox River. Without the Wisconsin River section, the Fox Waterway lost its national importance as a connecting link between the Great Lakes and the Mississippi. Since the communities along the Wisconsin River had diminished considerably since the crossing of the river by the railroad, the Army Corps did not consider the improvement of the river to carry local traffic (Merritt 1979: 257-58). As a local waterway, the Fox River required less depth along the channels and in the locks. Those locks the Army Corps had not replaced would require only repair (U.S. ACE [Report] 1839-1963 [serial 228D, H. Doc. 1, pt. 2, vol. 2, pt. 3, 1883: 1916]).

The Army Corps had begun to test the feasibility of improving the Wisconsin by "canalizing" the river with wing dams and dredging directly on the sand bars in 1868 prior to the sale of the Fox Waterway to the federal government. After reviewing the history of canalizing rivers between 1825 and the mid-1860s, Warren concluded that it was not a satisfactory method of achieving the depth required for navigation along the Wisconsin. The river's slope was too great, and its sandy bottom too unstable. Hence, he tested the method along the river prior to full-scale improvement and continued to favor the construction of a canal along the side of the river. His 1868 examination of the river had inspected the margins of the floodplain and locations of the terraces in relation to the river. From this survey, he had established a provisional location for the canal of 4' depth which crossed the river in several places to ensure an adequate water supply. He also projected the placement of the composite locks (U.S. ACE [Report] 1839-1963 [serial 1744, H. Doc. 1, pt. 1, vol. 2, pt. 2, 1877: 284, 285-87, 289-92; serial 1447, H. Doc. 1, pt. 2, 1871: 226-27]).

The officers who guided the testing were much less pessimistic about the outcome of these trials. However, Major D.C. Houston had analyzed a sand bar near Portage and found that it shifted an average of 39' each day (Merritt 1979: 256). And, Houston as did Warren observed as early as 1877 that the reason for the river improvement was to find an inexpensive solution to transporting goods between the Mississippi and the Great Lakes. If experimentation found that an expensive form of improvement such as a canal was necessary, then the railroad was a more practical solution to transportation needs (U.S. ACE [Report] 1839-1963 [serial 1744, H. Doc. 1, pt. 1, vol. 2, pt. 2, 1877: 4D1-02, 417-18]; Merritt 1979: 258). As a result of this ambivalence, the Army Corps attempted to improve the river intermittently between 1868 and the early 1880s using this method which ultimately failed. As noted, the improvement continued between 1868 and 1870 when Congress ended work on the river until an agreement was reached concerning the sale of the Fox Waterway. Improvement began again after the Green Bay and Mississippi Canal Company agreed to arbitration in March 1871.

Major Houston supervised the projects along the Wisconsin River as well as along the Fox River. During the 1871 season, he tested the wing dam and dredging approach in areas where the side canal crossed the river. His goal was to achieve a 4' to 5' channel through this method. The division of the Wisconsin River into numerous channels by islands required the construction of a comparatively large number of dams at most locations. Composed of brush weighed

down with stone and gravel, the wing dams were constructed to confine the river to a single channel. The dams projected out into the Wisconsin like spurs to catch the sand and eventually form new banks along the river. The dams sat low in the water so that they did not restrict the river's flow during high water. Additional dams reduced the width and increased the depth of the channel by concentrating the flow of the river. Because sand composed bed of the river, it yielded easily to the increase force of the stream flow. However, it was the continuous building and moving of the sand bars by the river which created unstable channels and unpredictable shallows and frustrated its improvement (U.S. ACE [Report] 1839-1963 [serial 1744, H.Doc. 1, pt. 2, vol 2, pt. 2, 1877: 399-400, 405-08]).

Dam construction occurred along two sections of the river: between Portage and Prairie du Sac and Lone Rock and Boscobel, a total of forty-six miles. In 1871, the Army Corps built twenty-two dams of 6,621 linear feet. By December 1, 1873, the agency had completed ninety-four dams totalling 38,517 linear feet. One wing dam erected prior to 1873 sat opposite the mouth of the Portage Canal and turned the channel from the west bank toward the entrance of the canal. In 1875, John Nader, assistant engineer, reported that the lumber rafts and steamer Ellen Hardy which carried grain between Sauk City and Portage flowed over the improved stretch between the two locations without hindrance. At this point, even Warren was relatively sanguine about the effect of the dams on the channel. This approach to the river's improvement continued until 1875. Because the progress of the work appeared slow and was questioned, the Army Corps focused its efforts on short sections of the river beginning in 1875 as recommended by Major Houston. At the end of 1875, the total number of dams reached 150 with a total linear length of 65,971'. Congress failed to appropriate funds to conduct the project between 1876 and 1877. Repair and extension of the existing dams and protection of the banks from the erosion absorbed available funding in 1878. Likewise, in 1879, the Army Corps expended considerable effort to maintain existing dams. Thus, by the end of 1879, the improvement continued to include 150 dams but totalled 74,634 linear feet. By 1880, the Army Corps had completed 157 dams totaling a linear length of 76,684', protected 5714' of banks at six locations, and removed 1523 snags and 7332 leaning trees.

In 1876, Warren completed his extensive report on his examinations of the Wisconsin River between 1866 and 1869 in which he favored improvement by the construction of a canal rather than erecting wing dams. The Board of Engineers for Fortifications and River and Harbor Improvements examined the Wisconsin River in September 1879. In its first report, the board observed that the results of the experiment were not sufficiently conclusive to warrant improvement of the entire river using this approach. It recommended further testing by constricting twelve miles of the river below Portage with wing dams to a channel width of 300'. This portion of the river had already undergone some modification in previous years and exhibited a slope somewhat greater than average. In 1881, the Army Corps completed forty-one wing dams at a total length of 19,308' for seven miles between Portage and Rocky Run. In the next four years, improvements were maintained, and the effect of the wing dams on the channel was recorded.

This portion of the channel showed little improvement after several years of

observation. In its report of 1884, the Board of Engineers reported that the use of wing dams without the construction of walls along either bank resulted in a variable depth. The shallows which the dams were intended to eradicate remained. However, the necessary walls were prohibitively expensive. The board recommended ending the Wisconsin River improvements until the navigation of the Upper Mississippi River was assured. In 1884, Houston observed that the east-west railroad network currently carried the goods intended for this route. Because of the need to transfer cargo at several points along waterway, the railroad provided a less expensive method of transportation.

The Board of Engineers made its final examination of the Wisconsin River improvements in 1886. In 1887, the Board recommended a cessation of this method of improvement. It concluded that the combination of the river velocity and unstable bottom did not permit its control in a navigation channel. If in the future a navigable channel of 4' to 5' depth between Portage and the Mississippi River became necessary, then the improvement was to utilize a canal adjacent to the river. Although later studies would reconsider the improvement of the Wisconsin River, this decision ended the effort to construct a channel along the Wisconsin River and create a through waterway between the Great Lakes and Mississippi River. The Fox River then transported primarily local commodities to the Great Lakes (Larson 1979: 178; Nicodemus 1874: 147-51; Wisconsin Governor 1840-1914 [1870, folder 5, box 10, 1880 letter from D.C. Houston]; Mermin 1968: 145-48; U.S. [Statutes] 1867-1958 [1886, vol. 24, chap. 929: 325]).¹³

Maintenance of the Channel along the Fox Waterway: 1886-1900

The decision to end improvements along the Wisconsin resulted in the modification of the project for the improvement of the Fox River. Without a through route, the Fox would carry only local traffic. However, in 1884, Major Houston emphasized the value of the improvement to local communities along the Fox River. It not only provided an inexpensive means to transport goods but indirectly reduced railroad freight rates in the area. The Board of Engineers found that the rapid growth of industry along the Lower Fox River would increase the importance of this section of the waterway. They also reasoned that the lack of project depth along the Upper Fox River had decreased the traffic along this section. In addition, there always remained the possibility that the canal along the Wisconsin River would be completed. Therefore, the board recommended not

¹³ Much of this data regarding the Fox Wisconsin is repeatedly provided in the following reports: U.S. ACE [Report] 1839-1963 [serial 1513, H. Doc. 176, 1872: 2-13; serial 1599, H. Doc. 1, pt. 2, 1873: 132-35; serial 1598, H. Doc. 1, pt. 2, 1874: 218, 229-32, 243-44; serial 1636, H. Doc. 1, pt. 2, 1875: 169-73; serial 1675, H. Doc. 1, pt. 2, 1876: 217, 224; serial 1744, H. Doc. 1, pt. 2, 1877: 241, 398-401; serial 1904, H. Doc. 1, pt. 2, vol. 2, pt. 2, 1880: 1534-35; serial 1955, H. Doc. 1, pt. 2, vol. 2, pt. 3, 1881: 1948-49, 1953-61; serial 2013, H. Doc. 1, pt. 2, vol. 2, pt. 3, 1882: 2133; serial 2280, H. Doc. 1, pt. 2, vol. 2, pt. 3, 1883: 1904-14; serial 2479, H. Doc. 65, 1887: 3-5; serial 2372, H. Doc. 1, pt. 2, 1886: 2025; serial 2631, H. Doc. 1, pt. 2, 1889: 1869]).

only maintenance but improvement of the waterway including the Portage Canal.

The project defined on December 10, 1884, placed the depth of the improvement to 6' at low water between De Pere and Montello and to 4' at low water between Montello and the Portage Canal. Channel width remained at 100' along its entire length. The depth along the Lower Fox had reached 5' and remained 3' on the Upper Fox. The report justified replacement of eight of the composite locks with stone locks along the Lower Fox River because of the level of local commerce. The four locks at the upper end of the Upper Fox including those at Portage were to be repaired. On May 14, 1886, the project was modified once again. Congress conclusively ended the experiment on the Wisconsin River portion. Additional dredging was to occur along the channel between De Pere and Green Bay and along the Neenah Channel. The eleven locks which had not undergone replacement were to be renovated rather than replaced. It specified that no further masonry locks were to be built along the waterway. The only canal receiving revetments along its full length was the Portage Canal. This project definition continued in force until 1925 (Larson 1979: 179; Mermin 1968: 147-50, 164; U.S. ACE, Milwaukee District 1951: 4; U.S. ACE [Report] 1839-1963 [serial 2372, H. Doc. 1, pt. 2, 1886: 2044-45; serial 2534, H. Doc. 1, pt. 2, vol. 2, pt. 1, 1889: 271; serial 2925, H. Doc. 1, pt. 2, vol. 2, pt. 4: 2572]).

After the federal government began operation of the Fox Waterway, numerous, often apparently contradictory claims were filed against it concerning the depth of the river and flowage rights. The communities and industrial interests along the Lower Fox complained of low water and loss of waterpower while those above Neenah and Menasha and in some cases west to Portage objected to the destruction and flooding of property by high water. During periods of high water such as those in 1885, the constricted channel at Neenah and Menasha provided no outlet for the flood waters and caused destruction of property along Lake Winnebago and the Wolf and Upper Fox rivers. Because the industrial interests downstream from Lake Winnebago depended on these dams for a portion of their waterpower, the dams could not be lowered. The Army Corps finally widened the Neenah channel beginning in 1887 to discharge the excess flood waters. Despite these efforts, the government continued to address claims for such flooding into the 1920s.

The sale of the Fox River Waterway by the Green Bay and Mississippi Canal Company to the federal government included only the water in the improvement necessary for navigation. The canal company retained rights to the water power created by flow beyond that amount. Thus, in periods of low water, the Army Corps restricted the use of water, principally along the Lower Fox River between Lake Winnebago and De Pere. In dry years, this action frequently closed the mills which relied on hydroelectric power. Steam powered only a small number of the mills. In November 1886, the government sued about thirty-one mill owners along the Neenah and Menasha channels to restrain them from drawing the water below the crest of the Menasha Dam. Such low water impeded navigation on the lower river. In 1887, the Army Corps report noted that the mills continued to draw more water than discharged by the Fox River so that navigation was partially suspended between July and November between Appleton and the lake. In 1891, the mills again reduced the level of the water below the dams at Appleton and Menasha.

In February 1895, the Army Corps published rules regarding the use of the Fox Waterway's facilities including its waters. Rule number twelve specified that the government prohibited the drawing of water below the crest of the dams along the Fox River or its associated waterways. In the same year, the courts proceeded to prosecute the offending mill owners. However, after this decision in August 1895, J.A. Kimberly observed to Governor William Upham during a particularly dry year that such action laid off many of the mill workers. Moses Hooper, attorney at Oshkosh, suggested to Upham in the same month that because of the loss of hydroelectric power along the Lower Fox, the federal government should strongly consider the diversion of the Wisconsin through the Portage Canal into the Fox River. The City of Chicago had constructed the Chicago Drainage Canal to move wastes from the Chicago area and reversed the flow of the Des Plaines River so that water flowed from Lake Michigan. In 1896, Congressman Miner made such a proposal to permit diversion of the water from the Wisconsin River as well as the addition of flash boards on the dam at Menasha. Interest in this proposal arose again in the 1930s when it was broached as a means of raising the level of Lake Michigan to compensate for the flow of water into the Illinois River. Finally, In 1896, the Green Bay and Mississippi Canal Company contended in court that, instead, navigation had become incidental to the production of waterpower along the Lower Fox. The court ruled in favor of the United States and the maintenance of navigation along the Fox Waterway (Larson 1979: 178; Meindl 1991: 36; Wisconsin Governor 1840-1914 [1882-97: folder 6, box 10, letters dated 8/13/95 and 8/28/95]; Fox River Navigation Company 1895-1911 [box 1, Times, 2/4/96]; Mermin 1968: 159-60).¹⁴

Congress directed the Secretary of War in 1896 to conduct a complete examination of the property and rights in the property owned by the United States along the Fox Waterway. The controversies concerning waterpower and flowage rights prompted the investigation. In 1897, Captain Zinn reported the results of his investigation of the United States title to the Fox Waterway gained through the Green Bay and Mississippi Canal Company and, originally, the State of Wisconsin. His description for the Portage Canal section included two lots at the east end of the canal and the 190' strip along the length of the canal.

The importance of the investigation at Portage related to the adverse claims of possession by several private land owners who claimed property virtually up to the canal itself. Some of these individuals had the employees of the Army Corps seeking to repair the canal prosecuted for trespass. Zinn indicated that adverse possession could not be claimed against the United States prior to its original sale of the land since title to the land originated at this point. He found no such claims against the state or the companies to which the land was granted.

¹⁴ References to this subject in the reports of the Army Corps are as follows: U.S. ACE [Report] 1839-1963 [serial 2372, H. Doc. 1, pt. 2, 1886: 2041-44; serial 2629, H. Doc. 1, pt. 2, 1888: 246; serial 2631, H. Doc. 1, pt. 2, vol. 2, pt. 3, 1889: 1870; serial 2925, H. Doc. 1, pt. 2, vol. 2, pt. 4; 1892: 2573; serial 3374, H. Doc. 1, pt. 2, vol. 2, pt. 4, 1895: 2662; serial 3432, vol. 2, pt. 4, H. Doc. 2, 1896: 2525-26, 2532-33]).

And, the issue which initially thwarted the Army Corps' active role in the development of navigable waterways was resolved. The United States had the power to control and improve all navigable waters, and the Army Corps represented an extension of that power. He concluded therefore, that the United States owned the 190' strip and parcels at either end of the canal. However, this controversy continued to periodically surface through 1983 (U.S. ACE [Report] 1839-1963 [serial 3748, H. Doc. 2, 1898: 2384-85; serial 3691, H. Doc. 389, 1898: 1-10, 33-34]; Larson 1979: 179).

Along the Lower Fox River, the Army Corps continued to rebuilt and renovate the locks. By 1880, it had replaced five of the locks using ashlar stone. Between 1880 and 1890, five additional locks were rebuilt as composite locks. Rebuilding then continued at a slower pace, one in the 1890s and two additional locks in 1903 and 1907. While these thirteen locks were replaced or rebuilt, the remainder of the locks received periodic repairs. The Army Corps rebuilt some of the crib dams as stone structures. After the initial renovation efforts between the mid-1870s and mid-1880s along the Upper Fox River, the Army Corps of Engineers conducted major repairs and rebuilding of the Montello and Governor Bend locks about 1900 and again in 1931 at Governor Bend. The five stone locks required little major work until their use was discontinued in 1951. Periodic dredging of the upper waterway continued until 1927. Sand bars frequently formed in the river east of the Fort Winnebago Lock. By 1899, dredging had attained a 6' depth between De Pere and Berlin, a 4' depth between Berlin and Montello, and a 3' depth remained between Montello and Portage (Vogel 1993: 51-55; Meindl 1991: 33-36).

At Portage, the Army Corps raised the banks adjacent to the Portage Lock to protect the lock from overflow by the Wisconsin River in 1888. In 1891, a brush and stone wing dam was erected to prevent the Wisconsin River from undermining the Portage Levee. The Army Corps finally replaced the wooden Portage guard lock with a lift lock between November 21, 1892 and July 31, 1893. The second lock, a 35' x 165' lock with a 2' to 8' lift at mean stage, abutted the east end of the existing lock when it was constructed in 1926-28 at the site of the first lock (photographs WI-104-11, 48). The remains of the current stone retaining walls along the canal banks just east of the existing or third lock may represent the remaining walls of the second lock.

The second lock was erected as a composite lock (photograph WI-104-46-47). Quick sand composed most of the 4121 cubic yards of material removed from the lock pit, headwall, and miter sill crib foundation areas. Cribbing was sunk under the miter sills and filled with stone to form a solid foundation. The miter sills sat 2.5' lower than those of the first lock. Concrete masonry composed the breastwall, and concrete filled the spaces between the new floor timbers. Dry laid stone filled the timber cribs of the side walls. Coping timbers and concrete finished the top of the lock walls. The side walls and floor timbers were finished with planking. Construction included four wood hollow quoins, four timber gates fitted with valves, and six snubbing posts. Stone-filled cribs also formed the lower or east wing walls. Little work remained to be completed in 1893. It included back-filling the space behind the walls with sand which was dredged from the canal and a bar in the Fox River near the Fort Winnebago Lock.

The floor of the canal adjacent to the lower or east end of the lock received riprap taken from the Fort Winnebago Lock. Wing walls west of the lock were formed from the walls of the first lock (U.S. ACE [Report] 1839-1963 [serial 2631, H. Doc. 1, pt. 2, vol. 2, pt. 3, 1889: 1875; serial 2925, H. Doc. 1, pt. 2, vol. 2, pt. 4, 1892: 2573; serial 3202, H. Doc. 1, pt. 2, vol. 2, pt. 4, 1893: 2762; serial 3299, H. Doc. 1, pt. 2, vol. 2, pt. 4, 1895: 2107]; U.S. ACE, Oshkosh 1896-99; Meindl 1991: 26-27; Portage Public Library n.d., ca. 1909-10 [photograph, n.d.]).

The Army Corps substantially rebuilt the Fort Winnebago Lock at the same location between January 14 and May 12, 1890. It remained a composite lock. With almost annual repairs and occasional rebuilding, this structure remained in place until partial replacement occurred in 1936. Edward Sargent of the Army Corps supervised the work under Major Charles Davis. Sargent based the design of the replacement lock on plans prepared for the Montello Lock, a composite lock constructed in 1868 (U.S. ACE, Chicago District n.d., 1873-1928 [13-G-18, tube 72/204, 1890, cost specifications from Montello Lock; plan 13-G-8, tube 72/204 based on Montello Lock]). He subsequently redrew the plans for the lock design (photograph WI-104-42) (U.S. ACE, Chicago District, n.d., 1873-1928 [plan 13-G-8, tube 72/204, redrawn lock plan, ca. 1890]).

Sargent hired S.A. Harrison and Company which was also erecting the Portage Levee to place fill behind the lock walls and move other materials into place. Day labor completed the remainder of the work. Cofferdams were erected on either side of the structure to drain the lock pit in late January. Between January 16 and February 28, the 1890 lock was removed down to the foundation and miter sills. Because the drawings purportedly illustrating the 1859 construction showed a plain skeleton frame such as the one erected between 1849 and 1851 rather than the existing bolted, solid timber cribs filled with large stones, this work required more time than the estimated. Until a derrick was secured, work progressed slowly.

To decrease the amount of excavation required to rebuild the Ft. Winnebago lock, four original timbers were left in place over part of the foundation. Longitudinal timbers provided the base of the floor. A continuous crib with exterior width measurement of 9' was then erected on this base to form each side wall. Beginning on March 17, S.A. Harrison and Company placed fill behind the crib walls and the wing walls. The company then filled the cribs of the lock and portions of the wing walls with rubble stone and concrete. A facing of 6" of concrete was placed between the timber cribbing and planking which formed the exterior wall of the chamber. This layer of concrete was intended to prevent water leakage from the lock. The west gate recesses, a cut stone portion of the lock wall pointed with Portland cement, extended west from the upper gate to receive the gate as it opened.

It is assumed that the timber gates of the Fort Winnebago Lock were replaced, but the brief report did not describe this phase of the work. The placement of one of the gate leaves and hollow quoin at the end of the gate near the wall recess is shown in an undated design included with the Fort Winnebago Lock plan. The miter sill is illustrated as a dotted line in front of the gate (photograph WI-

104-43) (U.S. ACE n.d. 1873-1928 [plan 13-G-6, tube 72/204, gate])). The area below the miter sill was stabilized with concrete at the west end. The pin and socket which fit on top of the quoin post and attached the gate to the side wall of the lock was shown in undated sections (photographs WI-104-44-45) (U.S. ACE n.d. 1873-1928 [plans 13-G-4 and 13-G-3, tube 72/204, gate details])). The maneuvering gears for the gates, the valve levers on top of the gates, the gate spars, and spar rests were then placed into position. Some of the iron hardware from the gates of the earlier lock were reused. A combination of timber revetments and stone walls formed the wing walls beyond each end of the lock. Even in the late nineteenth century, concrete was not extensively used. When it was employed, it served to provide a seal to prevent water leakage. The report carefully documents the type of hydraulic cement used and the amount of sand and gravel in the concrete to vouch for its quality. It specified use of recently manufactured Falls City, Anchor Brand from Louisville, Kentucky (U.S. ACE [Report] 1839-1963 [serial 2832, Doc. 1, pt. 2, vol. 2, pt. 3, 1890: 2365-66, 2378, 2388-89]; Portage Public Library n.d., ca. 1909-10 [photograph, n.d.])).

After the lock's reconstruction in 1890, the Fort Winnebago Lock received additional small repairs in August 1897 to the wing walls, tripod platforms, and gate hand rails (Bamberg 1866-1960 [1897: folder 6, box 2, pp. 262-63])).

The 1890 report noted that in March stone was taken from the lock and placed on the Fort Winnebago dam and shore protection which extended below the lock into the Fox River. Reports from the Milwaukee District in 1898 and 1913 noted that an old scow had been sunk to form the original part of the dam to arrest the movement of sediment. The additions made to this structure were intended to prevent erosion which had previously formed a sand bar at the entrance of the canal into the Fox River. The reports probably described a wing dam which are frequently constructed to halt the formation of such bars. Large scale maps dating between 1890 and 1936 also show a dam crossing the Fox above the entrance to the Fort Winnebago Lock (figures 9 and 11). This is not the usual position for a wing dam. However, if the dam created a pool of any significant size behind it, it would flood water into the waste weir and canal which exited into the Fox River above the dam (figures 9, 11). Therefore, all these references may be describing the wing dam referenced in the 1890 report. These maps dating between 1890 and 1934 also illustrate the straightening of the original channel of the Fox River by cut-offs, some of which were completed by 1866 (photograph WI-104-41) (U.S. ACE, Chicago District n.d. 1873-1928 [map 4-N-28.1, tube 56/204, west end of canal, 1934; map 13-C-1, tube 71/204, west end of canal, 1890; 13-C-5, tube 71/204, survey by L.M. Mann, 1896]; Bamberg 1866-1960 [1915, folder 2, box 4: 111; U.S. ACE [Report] 1839-1963 [serial 1278, S. Doc 16, 1867: 15])).

Also, although the U.S. Army Corps of Engineers report for 1878 indicated that a lock tender's dwelling was required for this site, no evidence indicates that it was constructed. The Army Corps did construct a single room tool shed by 1896 just northeast of the lock (photographs WI-104-55, 56) (U.S. ACE, Chicago District n.d. 1873-1928 [map 4-N-28.1, tube 56/204, west end of canal, 1934; 13-C-5, tube 71/204, survey by L.M. Mann, 1896]; Portage Public Library n.d., ca. 1909-10 [photographs, ca. 1910])). A plat of the vicinity of the Fort Winnebago Lock in 1884 continues to show the mill race which fed water to the mill

immediately adjacent to the south side of the lock structure as well as the waste weir. Probably built in 1875-76, the waste weir west of the Fort Winnebago Lock was also reconstructed in 1889 and repaired in 1891 (see figures 8-9). By the 1890s, the structure measured 61'-8' long, 11'-5" wide, and 6'-3" deep and appears to have been at least partially revetted with pine timber (Meindl 1991: 28-29; U.S. ACE [Report] 1839-1963 [serial 2832, Doc. 1, pt. 2, vol. 2, pt. 3, 1890: 2365-66, 2388-89]; Bambery 1866-1960 [1913, folder 2, box 4, p. 111]; U.S. ACE, Oshkosh 1896-99; Columbia County 1884 [deed plat w/waste weir and mill race]).

Repairs were made to the revetments, and the canal may have been dredged in 1891 and 1892. One of the last identified replacements of the pine timber revetments along a significant portion of the Portage Canal occurred in 1897. The Army Corps used a steam pile driver to set the pilings in place. The pile driver was stored at Berlin and hauled by the steam tug *Boscobel* to the work site. A Mr. Grover, the pilot, and Mr. Servaos, the carpenter, with crew, all employees of the Army Corps, completed the work. The rebuilding began at the Fort Winnebago Lock and proceeded west along the canal. Many of the timbers in contact with the earth proved to be in sound condition. The work appeared to consist of driving new piles just in front of the edge of the canal, placing piles along the bank of the canal, tying this second set of piles to the anchor piles, and placing new upper pine planks along the canal side of the piling bordering the canal. From this description, the Army Corps appears to have driven three set of piles along the bank, adding anchor piling to the drawing 4 in figure 10. Some of the revetments along the canal's edge were simply straightened and secured to the anchor pilings. Because of adjacent land owners charged the workers with trespassing, work was halted near one of the railroad bridges, identified as the upper or perhaps the west railroad bridge. Although replacement of the revetments later occurred adjacent to the locks, there is no indication that this systematic effort was ever resumed (Bambery 1866-1960 [1897: folder 6, box 2, p. 152, 232, 250-51, 263]; U.S. ACE, Oshkosh 1896-99). The Milwaukee District redrew 1876 plans for revetments along the Portage Canal in 1928 perhaps to repair revetments adjacent to the Portage Lock which was replaced between 1926 and 1928 (Photograph WI-104-34).

Promotion of The Deep Waterway Between the Mississippi and Green Bay: 1900-35

The 1906 report of the Army Corps of Engineers observed that the reduction of railroad freight rates and the creation of waterpower were the principle economic effect of the improvement and the reason for maintenance of the waterway. By 1906, the Army Corps had rebuilt twenty-six locks along the Fox Waterway. There were seventeen stone locks and nine composite locks as well as sixteen permanent dams, twelve short canals, nine lock houses, four warehouses, three timber sheds, repair shops at the Berlin and Kaukauna dry docks, seven masonry waste weirs, and additional associated structures. The federal government began replacing the deteriorating crib dams with concrete masonry structures on the Lower Fox between 1924 and 1941. While two locks on the Lower Fox were rebuilt in 1903 and 1907, the Army Corps replaced three additional locks at Rapide Croche, Little Kaukauna,

and De Pere with reinforced concrete structures between 1931 and 1939. In 1941, the Army Corps covered the upper portion of the Eureka Lock with concrete. It built the first concrete lock along the waterway to replace the existing Portage Lock between 1926 and 1928. The Fort Winnebago Lock remained a composite lock.

Except for modifications relating to the specific areas along the Lower Fox River, the 1886 project definition continued to delineate the work along the waterway. The project depth between Portage and Montello remained 4' at a width of 100'. The maximum actual draft by 1906 at mean low water reached 6' between De Pere and White River, 4' between White River and Montello, and 3' to 3.5' between Montello and Portage. By 1907, dredging had attained a 6' depth for much of the waterway to Princeton. The effort to attain the 4' depth meant almost yearly dredging by the Army Corps since the beginning of its operations until the 1920s when this operation was suspended because of limited use of the waterway. The lowering of the depth of the Fox Waterway caused the drainage of much meadowland along the Upper Fox, greatly increasing its value. Without dredging, the water depth between Governor Bend and Portage fell to 2' by 1933. By 1950, the depth of the waterway gradually decreased to between 1.5' and 1.8' at either end of the canal (Bamberg 1866-1960 [1906: box 2, folder 6, p. 287, 292]; Larson 1979: 158, 179; U.S. ACE, Milwaukee District 1951: 4; Richards 1995: 9; Meindl 1991: 36; Vogel 1993: 54; U.S. ACE [Report] 1839-1963 [serial 4279, H. Doc. 2, pt. 1, 1901: 526; serial 8005, H. Doc. 146, 1922: 18; 1933 [pt. 1]: 1041]).

As traffic diminished along the upper river, the Army Corps began to recommend the suspension of improvements along the Upper Fox and much of the Wolf River. In 1904, a district engineer suggested that improvement, primarily dredging, should cease between Montello and Portage until traffic warranted such expenditures. The 75' wide and 3' to 3.5' deep channel accommodated the small pleasure craft which used that section of the waterway. No commerce was then conducted on this portion of the river. Similar recommendations occurred in the district reports of 1908, 1910, and 1911. The lockage did rise significantly during the first decade of the twentieth century, but they primarily recorded the passage of pleasure craft. Presented to Congress in 1922, the reports of 1916 and 1921 which were authorized in 1915 indicated that abandonment should occur between the mouth of the Wolf River and the Wisconsin River. At this time, barges carried 1,000 tons on the Upper Fox, and it appeared unlikely that the volume of commerce would rise. Because railroad distances to Milwaukee were shorter than to Green Bay by canal from the Upper Fox and most manufacturing plants were then located away from the water, rail and the growing truck transportation were preferred. For these reasons, the district engineers indicated that removal of the improvements on the Upper Fox including the canal was warranted. The Board of Engineers recommended constructing a levee across the mouth of the canal and converting the land into a park. Without navigation on the Upper Fox, the plane of the water in Lake Winnebago could be lowered, permitting an increase in available waterpower and draining some of the wet meadowlands. The reports reiterated this recommendation during the remainder of the 1920s and in the 1930s (Mermin 1968: 160-61; U.S. ACE [Report] 1839-1963 [serial 4787, H. Doc. 2, vol 7, pt. 3, 1904: 2847-48; 1910 [pt. 2]: 2136; serial 8005, H. Doc. 146, 1922: 7-8, 11-13, 17; 1935 [pt. 1]: 1184]).

The recommendations concerning first the cessation of dredging and then the closing of navigation on the Upper Fox did not deter individual citizens, communities, and the state legislature from memorializing Congress concerning the development of deep channel navigation along the Fox and Wisconsin rivers in the twentieth century. The federal government had begun the development of deep channel navigation along selected waterways during World War I. Identified locations included the Mississippi River, New York Barge Canal, St. Lawrence Seaway, and Illinois River. During the 1920s and early 1930s, the Army Corps also deepened the channel through Green Bay. The 18' deep inner channel and turning basin reached completion in 1926, and the outer channel was improved by 1936. This combined activity prompted strong local support for the 9' channel along the Fox Waterway (U.S. ACE [Report] 1839-1963 [1937 [pt. 1]: 1184-85]).

However, the Milwaukee District Engineers Office both in 1924 and 1925 found that commerce on the waterway did not warrant the costly development of deep channel navigation. Nor would such a project significantly benefit the production of hydroelectric power on the Wisconsin River (U.S. ACE [Report] 1839-1963 [1927 [pt. 1]: 1372]). It noted that the available railroad transportation then prevented the shift to shipment by water. Many of the communities along the two rivers did not exhibit interest in the project. The 1922 report admitted that prior to the regulation of railroad rates, railroads paralleling the Fox River lowered their rates during the navigation season and for industries along the river. Such price discrimination was not conducive to the development of waterway commerce. Additionally, the reports argued that the Chicago Drainage Canal and Illinois River, a competitor of the Fox Waterway, would carry considerably more traffic at its completion (U.S. ACE [Report] 1839-1963 [serial 8005, H. Doc. 146, 1922: 25, 47]).

Citizens from Portage and other cities along the Fox River such as Oshkosh pressed for the improvement of a 9' channel by the early 1920s. They continued to claim that the Fox-Wisconsin Waterway was the closest route for transporting goods from the Upper Mississippi, particularly the Twin Cities, to the Great Lakes. A committee appointed by Governor Blaine protested the abandonment of the 9' deep channel project proposal along the Fox and Wisconsin in 1926. The Portage Deep Waterway Committee substantiated the need for a 9' channel through a report presented by O.J.G. Peters and H.H. Niemeyer on April 27, 1926, to the Rivers and Harbors Board (Peters 1926a: 1-7). The 1926 report documented potential use of the waterway and the need to increase project depth to 9' along the Fox-Wisconsin Waterway by gathering responses from location industries and retail and commercial businesses. The report urged a bill to authorize a survey of the waterway. Such a bill was introduced in Congress as a separate item in 1928 and 1929 without success.

Peters updated his 1926 report in 1930 and presented it to a public meeting in Oshkosh. His 1930 report noted that the locks along the Upper Fox were constructed to accept a 6' channel despite the project depth of 4'. He proposed that all new locks have a depth of 9'. It documented the potential tonnage which shippers with access to the waterway would send if a deep channel were made available and the savings in transportation costs in comparison with shipment by railroad. Also securing letters of support, Peters primarily contacted

businesses in Portage which shipped bulk commodities such as lumber, coal and oil, grain and other agricultural products, agricultural supplies such as fertilizers and feed, hosiery, stone, and paper. As part of his promotional campaign, Peters printed mailing envelopes with photographs of the canal in Portage in the same year (Peters 1926a; 1926b; 1930).

Because the Rivers and Harbors Act of 1925 and the Flood Control Act of 1928 authorized a survey of the Mississippi River and its tributaries, the Corps eventually responded to the improvement proposal. The resulting 1930 report commented on navigation, flood control, and the production of hydroelectric power. Regarding navigation, it again stated that the low level of potential commerce did not warrant the high cost of channel development along the Wisconsin and Fox rivers. The current construction of another 9' channel between the Mississippi and Great Lakes along the Illinois River fulfilled navigation needs. The natural limitations of the Wisconsin River required improvement by slack water system, an expensive undertaking. Little significant demand for through commerce existed on either the Wisconsin or Fox rivers to justify such cost, and rail shipment was then more economical than use of the waterway. Five potential power dam sites existed on the Wisconsin River below Portage, but their development did not appear economically feasible given the local demand. The Army Corps referred the report to the Mississippi River Commission as required by the Flood Control Act of 1928. The commission concurred with the conclusions and specified only that if dams for the production of hydroelectric power were erected on the Wisconsin River below Portage, provision should be made for navigation. Thus, although the Army Corps determined that navigation development was not feasible, it had begun to consider additional uses of the river as required by the legislation of the preceding decade (U.S. ACE [Report] 1839-1963 [serial 9254, H. Doc. 259, 1930: 1-3, 40-43]).

Despite the negative response of the Army Corps to the proposal in 1930, Congress authorized a preliminary survey for the project in the same year. However, the main focus was flood control. The 1932 report analyzed the damage by flooding along the Fox River and attempted to resolve the conflict between the production of waterpower, riparian ownership and flooding of lowlands along the river, and navigation. It did not specifically address the 9' navigation channel proposal. An unfavorable response from the district and division offices was presented to Congress in 1934. No report was printed (U.S. ACE [Report] 1839-1963 [serial 9564, H. Doc. 212, 1932: 1-4, 14-15; 1934 [pt. 1]: 1105]).

Despite recommendations by the Milwaukee District, the Portage Deep Waterway Committee continued to promote navigation along the waterway in the 1920s. The group attracted the interest of the Standard Unit Navigation Company of St. Louis. The Upper Mississippi Barge Line Company of Minneapolis provided towboats and barges to the Inland Waterways Corporation to begin operation of a barge line on the Upper Mississippi in the spring of 1927. Both St. Paul and Minneapolis constructed terminal facilities. The barge line and the Inland Waterways Corporation worked in cooperation with the Standard Unit Navigation Company of St. Louis who intended to run a line from Prairie du Chien where a terminal would be established to Portage and Green Bay. The Portage Deep Waterway Committee provided sufficient data to warrant the connection. The secretary of the barge

line, Albert Birge, concurred with the Portage Deep Waterway Committee that shipment of bulk goods by waterway was indeed the least expensive method of transporting goods. He claimed that this method of distribution carried the savings in newly developed mass production procedures to the consumer. Carl J. Baer of his company had developed a boat for shallow water navigation by adjusting the internal combustion engine to boat propulsion. These boats were able to navigate waterways as shallow as 3' to 4' deep. The navigation company attempted to make a trial run of the waterway in the summer of 1926, but the failure of the Portage Lock blocked their route.

The Register-Democrat indicated that the same data provided by the Portage Deep Waterway Committee persuaded the Milwaukee District Engineers Office to replace the Portage Lock which had recently failed with a substantial concrete structure rather than to rebuild the older-style composite lock. This lock, it was hoped, would be part of the deep channel route between Green Bay and Prairie du Chien then under investigation (Register Democrat 1926 [11/29: 1/1; 12/10: 1/7]; 1927 [1/11: 1/1; 2/5: 1/1]; Peters 1926a: 1; 1948: 8). The influence of what Birge identified as the "waterway movement" was considerable (Register Democrat 1927 [1/21: 1/7]). Although the lock was constructed, the plans for operation of the barge line along the Fox-Wisconsin Waterway apparently never materialized.

A small number of vocal supporters continued to advance the deep channel improvement proposal through the 1940s. A public meeting in Oshkosh in 1935 gave its support to the idea as well as to flood control measures. In 1948, O.J.G. Peters continued his advocacy of Wisconsin's waterways as a member of the Governor's State Committee to Safe Guard Wisconsin Waterways and of the advisory committee to the federal Rivers and Harbors Committee as well as the Portage Deep Waterway Committee chairman. By the late 1940s, Peters blamed the railroad and milling industries of the Lower Fox Valley for defeating the development of deep channel navigation. Peter's 1948 report to the Board of Engineers opposed the closing of the waterway. In it, he noted that the building of the 1926 concrete Portage Lock, the rebuilding of the lock at Governor Bend in 1930-31, the construction of high traffic bridge over the canal in 1928, and the 1937-38 Milwaukee, Chicago, and St. Paul lift bridge over the canal were intended to maintain clearance for the deep channel (Mermin 1968: 151-55; Register-Democrat 1927 [1/21: 1/7]; Peters 1948: 1, 7-8). Thus, the promotion of the deep channel along the Fox-Wisconsin and the building of the Portage Lock as a concrete structure were closely associated with Congress's program to promote cost-effective shipping by the improvement of key waterways for larger carriers.

During this intense period of navigation promotion, the maintenance of the canal except for dredging continued with almost annual attention through the 1920s. The Wisconsin River flood of 1900 caused water to rise about 7' in the vicinity of Portage during the month of April. On April 24, the Portage Levee broke at cattle crossings about a mile below the Portage Lock, allowing water to spread over a large area across the marshes and lakes surrounding Portage. The 1904 Army Corps report noted that the construction of levees had noticeably engorged the river, thus making floods higher. The flood carried away a portion of the Fort Winnebago Lock and washed out the canal banks in the Portage Canal adjacent to the waste weir west of this lock (U.S. ACE [Report] 1839-1963 [serial 4093,

H. Doc. 2, pt. 5, 1900: 3730; serial 4787, H. Doc. 2, vol. 7, pt. 3, 1904: 2847]; Bambery 1866-1960 [1900: file 1, box 3, p. 60-64]; Milwaukee Sentinel 1900 [4/29: 10/1-3]; Smith 1904: 101).

Repair of the Fort Winnebago Lock and adjacent canal bank began on July 25, 1900. The Army Corps brought three boom derricks and tools by scow from Berlin. The August report described the existing 7' thick by 14' high lock walls as rubble stone masonry faced with 8" x 8" pine timber secured to the masonry with iron straps and bolts. The hollow quoins, miter sills, and portions of the floor were badly decayed. The flood had removed the top two courses of rotting timber from the left wall and placed the face timber and masonry from the right wall into the lock chamber. The Army Corps began the project by removing debris and constructing 4' wide, 10' long, and 13' high concrete masonry T-walls which were laid perpendicular to the head or west end of the lock walls to provide structural stability. The fallen right wall was replaced between the hollow quoins with a wood frame including the mud sill, posts, and girts; filled with dry rubble masonry; and faced with a double sheathing of pine planking fastened to the timber framework rather than directly to the stonework. The timber framing was also tied to the rubble wall with iron tie-rods. The top courses of timber on the opposite wall were also renewed. The masonry breast walls and wing walls at the ends were repaired and pointed with Portland cement. The right hollow quoins, gate spars, and deck or floor were replaced, and the miter sills, gates, and maneuvering gears for the gate valves were repaired. A concrete floor was laid between the miter sills. The pine tripod platforms were repaired, and the tripods secured to the new pine spars which connected to the gates. Three oak snubbing posts were placed along the top of each wall. Repairs to the lock were completed on October 6, 1900, and the structure was back-filled.

Along the canal adjacent to the waste weir (figure 9), the fifty-four linear feet of revetment damaged by the flood were straightened, a double row of 2" x 12" sheet piling was driven behind the revetment, and these structures were secured by tie rods to posts driven into the bank. The waste weir itself was revetted with planking. The Portage Levee also received repairs which were completed on September 13 (Bambery 1866-1960 [1900: file 1, box 3, p. 60-64, 117-149]; U.S. ACE [Report] 1839-1963 [serial 4282, H. Doc. 2, pt. 4, 1901: 2964-65]). In 1901, the Army Corps used Dredge No. 5 to clean the canal and removed the coffer dam at the Fort Winnebago Lock. Sand fill was also placed behind the walls of the Portage Lock. During operation of the dredge, the locomotive which had fallen into the canal at the railroad bridge was removed (Bambery 1866-1960 [1901: file 1, box 3, pp. 60-64, 207-208, 246-48]).

In October 1904, the Army Corps constructed a 12' square tool shed at Berlin and transported it to the Fort Winnebago Lock, replacing the building standing at the lock since 1896. It was placed along the north bank at the east end of the lock (Bambery 1866-1960 [1902: file 1, box 3, pp. 392]; U.S. ACE [Report] 1839-1963 [serial 4787, H. Doc. 2, 1904: 1876]).

In October 1900 after the flood, the Army Corps completed minor repairs at the Portage Lock. Old, broken concrete was removed, and the crib walls were refilled to their tops with concrete and a layer of cement mortar. The Portage Lock

received substantial repairs between November 5, 1901 and May 1902. To prevent the Wisconsin River from washing into the canal during high water similar to the flood of 1900, the Army Corps raised the upper or west wall 7'. Cofferdams were placed at either end of the lock. The stone and concrete fill in the cribbing of the Portage Lock was removed to 6' below the top of the existing wall. The pine and fir timber work along the locks walls including the posts was repaired to the water line, decayed sheathing was replaced, and the walls were raised. Stone and sand were placed in the cribbing to within top 6" of its top. The top of the lock walls was filled with concrete to hold the gate anchors and other hardware. The spar blocks, gate spars, and associated tripod platforms were renewed and put in place. Six snubbing posts were set along the top of the lock walls. The stone breastwalls were also rebuilt and raised 3.5'. The head wall at the west side of the lock was repointed with cement mortar in 1904. Last repaired in 1892, the timber crib walls of the first lock which stood west of the current lock were rebuilt to retain the banks and back-filled with sand. Old crib walls were occasionally left in place to serve as shoring for the banks at one end of a new lock. The Army Corps had constructed a warehouse along the south side of the Portage Lock by 1902 when it raised it on piers (photograph WI-104-35; Bamberg 1866-1960 [1901-02: folder 1, box 3, pp. 273-317]; U.S. ACE [Report] 1839-1963 [serial 4282, H. Doc. 2, pt. 4, 1901: 2965; serial 4787, H. Doc. 2, 1904: 1876]; Portage Public Library n.d., ca. 1909-10 [photographs, ca. 1909 and 1910]; Wisconsin Visual Archives 1855-1947 [photographs, ca. 1909]).

In June 1902, the Army Corps began to replace the pile revetments along both sides of the canal east of the Portage Lock for a distance of 130' to 150'. A portion of the crib walls of the first lock was removed to permit the placement of the revetment. Cedar pilings were placed along the canal's sides at 5' intervals and 6" x 10" pine timbers were bolted horizontally to their face. A second row of 4" x 10" timbers were bolted to the rear of the vertical timbers and sheet piling was driven behind these rear timbers. The revetment walls were anchored by piles driven 14' back from the canal banks (Bamberg 1866-1960 [1902: file 1, box 3, pp. 316-17]).

In 1904, the report of the Milwaukee District of the Army Corps stated that the Portage Canal had been in poor condition for a considerable period. The timber revetments were rotting and sewage and materials which were washed-in or were thrown in from the banks were filling the channel. Because residents had so fully occupied the canal's right-of-way with buildings along the west part of the canal, the Army Corps remained unable to access the banks to conduct repairs. Despite the extensive title search conducted by Captain Zinn in 1896, the property rights issues along the canal remained unsettled. Given its limited usage, the report indicated that additional funding should not be allocated to the improvement of the canal (Bamberg 1866-1960 [1904: folder 6, box 2, p. 293]).

After 1903, the Army Corps completed minor repairs to the wood frame and wood connections at both locks almost annually. The detailed district reports from the Bamberg Papers dating from 1896 to 1918 and the summary reports of the Army Corps clearly indicated that the cost of maintenance to these wood lock structures remained high.

The Army Corps repointed the head walls of the Portage Lock with Portland cement in 1903. In July and August 1905, it completed repairs to the lock's wood hollow quoins, connecting gate arms, and gates and replaced several gate spars and hand rails on top of the gates. In 1907 and 1908, references noted replacement of portions of the tripod platform and valve arms at the Fort Winnebago Lock and the rejuvenation of the timbers along a wing wall at the Portage Lock (U.S. ACE [Report] 1839-1963 [serial 4787; H. Doc. 2, vol 7, pt. 3, 1904: 2857]; Bambery 1866-1960 [folder 2, box 3: 1905: 96, 117; 1907: 293; 1908: 345]). Further minor repairs continued in 1909 and 1910 at both locks (Bambery 1866-1960 [1909: folder 2, box 3, p. 431; folder 3, box 3, pp. 13]). In 1912, the waste weir near the Fort Winnebago Lock was replaced and a bridge was built over its entrance to the canal (Bambery 1866-1960 [folder 3, box 3, 1910: 51-54, 93; folder 3, box 3, 1912: 93]).

Significant work did not occur at the canal until 1913. The Portage Lock had become badly decayed. The Army Corps began rebuilding the crib walls above the surface of the water in June. The west end of the lock walls was raised a foot to reach the height of the adjacent levee which was raised by the state. The rebuilding of the walls continued until November. In 1914, the timber facing along the entrance to the canal was removed and replaced with stone and concrete walls. Likewise in 1914, substantial repairs at the Fort Winnebago Lock included the replacement of the timber facing along the interior of the lock chamber. However, the Army Corps completed little work along the sides of the canal away from the locks. Evidently, the situation which existed in 1904 continued until 1916. In that year, considerable dredging was completed in the canal but the revetments were not replaced (Bambery 1866-1960 [1913-16: folder 3, box 3, pp. 199, 207, 235, 299-323]; U.S. ACE [Report] 1839-1963 [1913 [pt. 2]: 2797; 1914 [pt. 2]: 2914]).¹⁵

In 1926, the Army Corps replaced the second Portage Lock with a concrete structure (figures 12-13). This structure continues to stand at the Wisconsin River entrance to the canal. The collapse of one of walls of the Portage Lock in the summer of 1926 required either substantial rebuilding or replacement of the lock. Its replacement provided a larger capacity of 209'-0" x 35'-2" and a 2'-4" lift. The lock became largest on the Fox Waterway (Register-Democrat 1927 [2/5: 1/1]). Its size and concrete composition were in part influenced by the "waterway movement" for deep channel navigation of the 1920s. Because of its limited current and potential use, the Lakes Division engineer at Cleveland, Colonel Spencer Cosby, displayed considerable reservation about the construction of the new lock without direct authorization from Congress. A lock of the contemplated size appeared unnecessary given the project depth of 4' and the size of smaller locks along the remainder of the waterway. Additionally, the government's title to the entire property required for the lock then remained in question. Despite the views of the division engineer in September 1926, the district engineer determined that since Congress had not acted on the

¹⁵ Since detailed reports from the Milwaukee District Engineers Office were not located for the period after 1918, the level of work at the canal is not well documented.

recommendation of the Army Corps to close the waterway for five years, the agency was obliged to repair or replace the lock (U.S. ACE, Milwaukee District 1926b [letter from Col. John Kingman, 9/8/26]).

The project occurred under the direction of the district engineer, Colonel John J. Kingman. The Milwaukee District prepared the plans and specifications for the concrete lock, completing the first draft on June 12, 1926 (photographs WI-104-49-54). Prepared by July 30, 1926, the specifications posted August 30, 1926, required the construction of a concrete lock with steel gates and steel operating mechanism; the removal of the remaining walls of the first lock; the repair of the walls of the second lock to secure the banks; the building of a short levee to connect the new lock to the existing Portage Levee along the east bank of the Wisconsin River and around the Curling Rink; and the removal of an existing timber and clay coffer dam. This coffer dam was replaced in the fall of 1926. The size of the lock chamber was to measure 35'-2" x 170'-0", the length of the overall lock without the wing walls extended 209'-0", and the total height of the lock reached 28'-2". Truncated inward and keyed into the slab floor, the side walls measured 12'-0" wide at the base and 6'-6" wide at the top. The district opened the construction bids for the lock on August 20, 1926. It awarded the contract on September 23, 1926, to M.E. White Construction Company of 1735 Fullerton St., Chicago. While the company had not conducted river and harbor projects for the federal government, it had completed contracts requiring extensive concrete and grading work for the Milwaukee Electric Railway and Light Company and the Chicago and Northwestern Railway Company. Although the original contract completion date for the project dated September 16, 1927, it reached completion on May 5, 1928 (U.S. ACE, Milwaukee District 1926b [appended letters]; Register-Democrat 1927 [10/20: 1/6]).

The project began by mid-October 1926, and continued into the spring of 1928 at a cost of \$122,199. E.B. Johnson and later William Wagner supervised the project for M.E. White. The number of men working on the job varied according to the specific tasks being performed. The contractor had an upper limit of about fifty men working on any one day. A.F. Everett and E.M. Nisen from the local engineering office at Appleton served as the associate engineers for the project. Nelson Wightman and after February 1927 Uno G. Ohman served as the inspectors for the Army Corps and maintained a log of the work (U.S. ACE, Chicago District 1926-28 [books 24a-24b]).

The company began by clearing the area of brush and debris. During late October, M.E. White and Company set up its seven and a half ton, eighty horse power Kewaunee boiler, 140 ton caterpillar steam hoist, one rolling derrick denoted as the "A" derrick, additional derricks, two vulcan steam hammers, a clam bucket, two massive concrete mixers, and concrete hopper (photograph WI-104-50, 52-54). A seventy horse power engine generated steam to heat the concrete used in the lock for pours during the winter months. M.E. White secured its cement through Consumers Lumber Company which in turn purchased the eight to 9,000 barrels of cement from the Manitowoc Portland Cement Company (U.S. ACE, Chicago District 1873-1928 [4-N-28, tube 56/204, plans, 5 sheets]; U.S. ACE [Report] 1839-1963 [1926 [pt. 1]: 1280; 1927 [pt. 1]: 1303; 1928 [pt. 1]: 1352]; Register-Democrat 1926 [9/4: 1/6; 9/26: 1/1; 10/28: 1/1; 11/23: 1/3; 11/29: 1/1; 12/11: 1/7]; 1927

[1/11: 1/1; 2/5: 1/1]; Meindl 1991: 27).

By early December, the company had completed the first of two coffer dams and a sand dike levee at the entrance to the canal (photograph WI-104-52). In February 1927, the second coffer dam was placed between the second lock and Wisconsin Street. Sand bags supported between two interlocking rows of Wakefield steel sheet piling and tied horizontally with whalers and tie rods composed these dams. The steam pile driver drove in the sheet piling. The temporary sand dike levee extended southeast from the southwest corner of the existing lock to protect the Curling Rink which stood adjacent to the south side of the canal at the time of the lock's construction.

After draining the site of the new lock, M.E. White began the removal of the end walls of the second lock (photograph WI-104-48) and the timbers of the floor of the first lock, the site of the new lock, in December 1926. The stone from this demolition was placed at the west end of the lock site for use in the masonry wing walls. Excavation of the lock chamber and the leveling of the base of the excavation to receive the floor slab occurred during the winter months. As it proceeded, the sides of the excavation were braced with sheet piling and a grid of large timbers (photograph WI-104-54). By mid-February 1927, the contractor began placing the wood forms for the first section of the lock. Simultaneously, steel sheet piling was driven for the cut-off walls which secured the outward weight of the concrete walls. Because of the cold weather, the pouring of the first section at the east end of the site did not begin until early April. The water and sand pressure also caused the sheet piling supporting the slab forms to move out 4" at the bottom and resulted in the settling of the existing lock walls. Corrections for this pressure which was not provided for in the original design also produced considerable project delays.

The construction firm poured the first floor section on April 11, 1927. Construction proceeded from the east end west in six sections. After driving the steel sheet piling and setting the forms and two layers of rebar, the contractor poured the entire section without halting work to ensure the fabrication of a monolithic slab without fractures. This effort required two work shifts. After setting in place the sheet piling and upright rebar and ties, the south wall of the first section was poured on April 29, and the forms were removed three days later. The steel sheet piling behind the concrete walls was removed considerably later. The north wall was poured on May 10. Preceded by final excavation, this sequence was followed for all six sections (photograph WI-104-54). As they went, the contractors continued to encounter springs which were boxed-in. To decrease the seepage around and under the structure at the west end near the Wisconsin River, the sheet piling along the walls was driven downward further than in the other sections. The contractor completed the concrete wall sections in early October 1927. In addition to building the wood forms, the project carpenters fashioned the hollow quoins at the site.

Repairs to the walls of second lock began by October 1927. During the rebuilding of the north wall of the west end of the lock, steps were built from the lower wall of the second lock to the higher wall of the new lock (photograph WI-104-51). In October 1927, the miter sills were poured and the building of the cut-

off walls, wing walls, and tripod platforms was continued. Removal of a portion of the west end of the curling rink building became necessary to drive the piles of one of the cut-off walls. The contractor received the structural steel for the gates from the Lakeside Bridge and Steel Company in late October for assemblage at the site. This subcontractor fitted the steel gates to heel post in late October and November.

By January 1928, the contractor was completing stone masonry wing walls using stone from the first lock, building the concrete cut-off walls, repairing the walls of the second lock, erecting the tripod platforms, and placing the gate spars, spar rollers, and tripods. This work continued into early March. The building of the short levee at the left or south side of the upper lock around the curling rink, backfilling the site, cleaning out the channel of the second lock, pulling sheet piling, and repairing several of the adjacent buildings damaged by the construction occurred in March and early April. M.E. White and Company removed the coffer dam from the east end, tested the gates at the end of March, and dismantled the west coffer dam in April. The canal was filled with water on April 28, 1928. The Portage Lock reached completion on May 5, 1928, and the work crews were discharged (photographs WI-104-36-40, 48-54; U.S. ACE, Chicago District 1873-1928 [4-N-28, tube 56/204, plans, 5 sheets]; Porter 1926-28; U.S. ACE, Chicago District 1926-28 [books 24a and 24b]; Register-Democrat 1927 [10/20: 1/6]).

The dredge known as the Winneconne cleared only a portion of the canal in 1927. Adjacent areas of the Upper Fox were probably never dredged despite the assurance of the district engineer (Register-Democrat 1926 [11/29: 1/1]). In May 1931, Mayor Niemeyer of Portage requested dredging of the canal and the installation of docking facilities. The May 18-19, 1931, inspection of the site by the Army Corps indicated that a sand bar had formed along the east side of the Wisconsin River so that a shallow, 18" deep channel provided entrance into the canal and weeds choked the canal at its west end. Canal revetments at the west end of the canal had deteriorated, permitting bank material to slide into the canal. While weeds also obstructed navigation in the east portion of the canal, the inspection found the bank revetments to be intact. The district engineer indicated that because of the absence of commerce and the low prospect of future commerce, the Army Corps had not performed dredging of the Upper Fox and canal since 1927 and did not recommend such action. For this reason, the Army Corps did not completed the requested project (U.S. ACE, Milwaukee District 1926b [appended letters from H.M. Trippe, 7/15/31]).

Several bridges spanning the canal were replaced. One of the traffic bridges was completed in 1928. Portage contractor William Kutzke constructed the new lift bridge owned by the Milwaukee, Chicago, and St. Paul Railroad in 1937 and 1938. It replaced the existing lift bridge over the canal at the current railroad crossing. Built during an era when few large boats used the canal, the bridge was lifted manually only for inspections in 1938 and 1940. After the Army Corps of Engineers ceased to maintain the canal as a navigable waterway, the railroad removed the counterweights in 1952 and the bridge's superstructure in 1968

(Portage Daily Register 1/14/37¹⁶; Columbia County Historical Society 1982; Portage Chamber of Commerce n.d.; Peters 1948: 8).

Thus, although supporters of the deep channel along the Fox and Wisconsin rivers had convinced the Army Corps to erect a substantial lock in the mid-1920s, they remained unable to develop the waterway to carry the deep draft, contemporary commercial vessels or in the long run to ensure maintenance of the waterway.

Federal Abandonment of the Navigation Improvement along the Upper Fox Waterway: 1935-62

Except for the surge of activity related to the replacement of the Portage Lock, some dredging of the Portage Canal between 1926 and 1927, and ongoing investigation of the feasibility of the 9' channel, the level of improvement along the canal as well as the Upper Fox continued to decline. The channel depth at low water between Portage and Montello fell from 2' in 1936 to 1.5' to 1.8' in 1951 (U.S. ACE 1839-1963 [1933 [pt. 1]: 1041]; 1951: 4). While the average lockage along the Upper Fox rose in the second decade of the twentieth century because of the increased popularity of pleasure boats, a parallel rise in commercial traffic did not occur. Freight carriage along the Upper Fox all but disappeared just after World War I, and overall use along the Upper Fox declined significantly during the 1920s.

At public meetings concerning the disposition of the waterway in 1945 at Portage and Oshkosh, the district engineer from Milwaukee indicated that no federal appropriations had been recently made for maintenance along the waterway. The Army Corps had completed little work along the upper river for a considerable period. He indicated, however, that to properly control the flow of water, sizeable appropriations would be needed to update the structures after several years of neglect. As illustrated by the work in the late 1890s and the first two decades of the twentieth century, the composite structures along the Fox had required relatively constant maintenance to keep them in operating condition. The public sentiment expressed at the two meetings opposed the closing of the Upper Fox and the suspension of lock service in 1945. In the same period, opposition was voiced at additional public hearings and through petitions. The reasons for such opposition ranged from the potential decline of recreational opportunities, flooding and expanding marsh areas, reduced waterpower along the Lower Fox, adverse effect on wildlife habitats, rising sewage and health problems with the reduction of water flow, and even the fear of rising railroad rates despite the lack of commerce along the Fox River. Many of these concerns related to a fear of fluctuating water levels. Since the dams and canals were to remain intact, this problem then appeared to be an unlikely result. By the time of the public meetings held to consider the construction of fixed bridges in 1949 and 1951, limited public comment was voiced. It primarily came from O.J.G. Peters who remained an active advocate of improvement along the Fox and Wisconsin rivers

¹⁶ Newspaper references without page and column notations were taken from the clipping collection at the Portage Public Library.

(Mermin 1968: 156, 162-63; Register-Democrat 1936 [5/28: 5/6-8]; Madison Capital Times 1952).

Despite the suspension of most of the maintenance along the Upper Fox River by the 1930s, minor work at the Portage Lock and the rebuilding of the Fort Winnebago Lock did occur beginning in August 1936. Carl Hilgenberg, a foreman from the Kaukauna Army Corps office, guided hired labor to complete both projects. No mention was made of the use of the Depression Era work programs typically sponsored jointly by the Army Corps of Engineers and the Work Progress Administration or the Civilian Conservation Corps. At the Portage Lock, the work crews probably removed a portion of the second lock walls and replaced them with docking. The reconstruction of the Fort Winnebago Lock involved rebuilding the floor, at least a portion of the timber side walls, and the gates. At completion of the rebuilding project at a cost of \$38,650, the structure remained a composite lock with dry laid, stone masonry walls surrounded by timber cribbing sheathed with pine planking along the lock chamber. The floor of the chamber was wood. At the top of the lock, the width of the walls measured 4'-4" across the lock chamber and 6'-0" across the upper or west gate recess (figure 11). The crib walls were considerably wider at the base than to top. The inside of the lock chamber measured 34'-8" wide, and the available length reached 137'-0". The lock provided a lift of 6'-5" (U.S. ACE [Report] 1839-1963 [1937 [pt. 1]: 1192]; Wisconsin State Register 1936 [7/7: 2/2]; Meindl 1991: 28; WDNR, Southern District 1946-74 [map of canal, 1957]).

During the early 1940s, the Army Corps continued limited maintenance of the Portage Canal structures. As the 1940s progressed, World War II drew funds away from non-essential government projects including the maintenance of the Fox Waterway. Consequently, between 1943 and 1950, the Portage facilities received little attention (U.S. ACE 1940-53). In 1940, the Army Corps rebuilt the waste weir west of the Fort Winnebago Lock. In 1941, the agency placed stone paving and conducted other miscellaneous repairs along the upper right or north bank above or probably west of the Portage Lock. The Army Corps removed debris from the entire length of the canal in 1942. In 1944, the Army Corps directed James Bambery¹⁷ of the U.S. Engineers Office at Appleton to replace the badly deteriorated oak hollow quoins, clean and repaint the steel along the gates and mechanisms, clean debris from the lock chamber, and conduct other minor repairs at the Portage Lock. And, in 1946, the agency removed debris and mud from the Portage Lock chamber and painted both pairs of steel gates. Under the supervision of the Army Corps foremen, temporary, hired labor performed this work (U.S. ACE [Report] 1839-1963 [1941 [pt. 1, vol. 2]: 1591; 1942 [pt. 1, vol. 2]: 1547; 1942 [pt. 1, vol. 2]: 1365; 1947 [(pt. 1, vol. 2): 1881]). Between 1950 and 1953, the Army Corps allocated minimal amounts for the Portage Canal and Fort Winnebago Lock. The relatively recent construction of the Portage Lock as a concrete facility and the rebuilding of the Fort Winnebago Lock may explain some of the reduced maintenance considerations (U.S. ACE 1940-53 [11/25/1944, 12/4/50, 9/21/51, 8/19/52]).

¹⁷ Bambery's papers are placed in the Green Bay regional archives of the State Historical Society of Wisconsin (see Bambery 1866-1960).

The Army Corps of Engineers considered the transfer of all the properties on the Upper Fox River to the state or a local agency in 1950. By this period, the Army Corps found that administration of the Upper Fox properties no longer met the definition of its basic responsibilities, navigation and flood control. It considered flood control problems to be negligible along this section of the waterway. The agency closed the Upper Fox Waterway to navigation between Portage and Eureka on July 7, 1951. It administered the waterway under custodial maintenance which enabled continued operation of the dams (U.S. ACE 1839-1963 [1951 [pt. 1, vol. 2]: 1746; serial 12062, S. Doc 1710, vol. 2, 1958: 2-3]).

For disposition of the properties along the Upper Fox, the Army Corps initially proposed the creation of a park along the Upper Fox, an idea first broached in 1921. The National Park Service suggested the development of a local or state park. In 1952, M.W. Torkelson of the State Planning Division prepared a report for Governor Kohler indicating that the lands did not meet the criteria for the establishment of a state or local recreational park. The development of the Upper Fox for recreational boating appeared costly and was probably unconstitutional because it appeared to meet the definition of an internal improvement. Torkelson did not recommend acceptance of the property by the state. However, in 1954, the Wisconsin Conservation Commission with input from the U.S. Fish and Wildlife Service reported favorably on the acceptance of the property for recreational purposes, primarily hunting and fishing. It indicated that specific changes would be required prior to property transfer to enhance their recreational value. The Conservation Commission recommended the closing of the lock structures and the placement of water control structures at key points along the waterway to create water levels most appropriate for the preservation of wildlife (Meindl 1991: 23; Mermin 1968: 163; Kabat 1957: 20-23).

The 1958 river and harbor act, Section 108 of Public Law 85-500, provided for the transfer of the properties by quitclaim deed and for \$300,000 to place the property in the status specified by the Conservation Commission (United States 1867-1959 [1959 (vol. 72): 297]); U.S. ACE [Report] 1839-1963 [serial 12062, S. Doc 1710, vol. 2, 1958: 2-3]). In May 1959, the Wisconsin legislature accepted the terms of the transfer in Chapter 56 of its laws pending determination by the Conservation Commission that the Army Corps had placed the properties in the condition specified in their agreement of September 8, 1958 (Wisconsin, State of [Laws] 1848- [1959: 76]. By this agreement, the Army Corps filled four of the locks, converted two to water control structures, altered the Fort Winnebago Lock to a waste weir to control water levels, and retained the Portage Lock to serve as a water control structure within the Portage Levee. Operated by the Berlin Boat Club, the Eureka Lock began operation again in 1958. The dams and canals were left in place (U.S. ACE, Chicago District 1958-59).

After fulfilling its agreement, the federal government quitclaimed the property along the Upper Fox to the State of Wisconsin in 1961. The state formally accepted the property on October 23, 1962 after the Conservation Commission determined that the Army Corps had fulfilled its agreement. The Conservation Commission then administered the property. The Army Corps transferred the property to the state with the understanding that the lands would be held for public benefit. This restriction was removed in 1972 (Meindl 1991: 23, 26;

Mermin 1968: 163-64; Kabat 1957: 20-21; U.S. ACE [Report] 1839-1963 [1962, [vol. 1]: 1272-73]; WDNR, Facilities and Lands 1951-87 [file: 1958-72, Resolution for Acceptance of Federal Properties, 8/17/62]).

Modification of the lock structures for transfer by the Army Corps began shortly after November 12, 1959. Modification of the Portage Lock to a water control structure involved limited alteration. The Army Corps removed much of the hardware including the spars, tripods, and tripod platforms and stock piled them at a warehouse near the upper Appleton Lock or Lock Number One; retained the valve rods and handles and safety hand rails along the gates as well as the gate levelers and plates; filled some of the areas left by removal of tripod bases; and lowered the stone walls of the second lock which remained visible west of the current lock and reshaped the slope of the adjacent banks to a one-to-one slope. The steps between the two locks were retained. Then, at the time of the transfer, the walls, gates and hollow quoins, valves, valve maneuvering gears, and iron snubbing posts of the Portage Lock remained in place. Both pairs of gates were welded closed. In the meeting of 1954 between the Conservation Commission and the Army Corps, the existence of a 15' x 33' building was noted to be in poor condition. The manner of its disposition was never indicated.

Prior to its transfer, the Army Corps dismantled most of the Fort Winnebago Lock. The hardware, most of the wing walls, and east gates and associated connections were removed. The side walls not required to support the west or upper lock gates, the walls within 10' east of the upper gates, were dismantled to the water line and the stone was thrown into the lock chamber. The banks were sloped at a one-to-one ratio. The west gates were cut down to the level of the existing waste weir which was 900' upstream and secured in a closed position to serve as the new waste weir. The valves in these gates were closed by dumping fill material against the upstream side of the gates. Stone fill was also placed on the east side of the gates and sloped eastward at a one-to-one ratio from the top of the new waste weir. The 10' x 12' frame, tool house remained standing after 1959. The Army Corps raised the dike at the location of the existing waste weir to the height of the adjacent canal banks (U.S. ACE, Chicago District 1958-59; East Central Wisconsin Regional Planning Commission 1948-85 [file: transfer of Upper Fox to State, 11/2/59]; WDNR, Facilities and Lands 1951-87 [file: Fox River Investigation, 1951-60, 1954 report and 9/10/58 letter]; Kleist 1987: 31).

State Management of the Portage Canal: 1962-

After 1962, the Wisconsin Conservation Commission, which became the Department of Natural Resources under Chapter 75 of the 1967 laws (Wisconsin, State of [Laws] 1848- [1967: 166-68]), and the City of Portage entered into a long planning process to consider the appropriate disposition of the Portage Canal. This period involved little physical modification of the Portage Canal and locks other than deterioration. In 1964, a governor's task force investigated the potential uses and problems related to the administration of the Upper Fox. Two subcommittees of the Task Force examined the historic sites in the Portage area and the Portage Lock and considered approaches to their management and interpretation. Their 1965 report noted that the constitutional prohibition

against spending funds on internal improvements restrained the state's allocation of funds to the canal's maintenance. Appointed in 1966, the Governor's Portage Canal Implementation Committee was directed to prepare detailed plans for these sites. Frank and Stein submitted a feasibility plan for the interpretation of the Portage area historic sites in 1968. Another portion of the plan considered management of the water resource. In conjunction with this study, the Ad Hoc Committee for the city addressed the long range development goals for the canal and submitted a report in May 1971. The State Bureau of Parks and Recreation considered the creation of a Fort Winnebago Historical State Park in 1972. However, owners of the Fort Winnebago Site which stands adjacent to the canal did not wish to sell their property. Each of these studies verified the historical value of the property and suggested an approach, but failed to determine the lead agency for its development.

The City of Portage created a waterway commission in 1973 to oversee the management of the canal. In October 1973, the city and the Department of Natural Resources began to consider different maintenance options for the canal. Although the accumulation of pollutants and debris in the canal had been a chronic problem since 1946, maintenance of the property remained negligible until the early 1970s. A drowning death in the Portage Lock led to the construction of a cyclone fence around the structure in 1968 (WDNR, Facilities and Lands 1951-87 [file: 1963-76: Upper Fox River Public Access]). The first identified effort to remove debris from the canal occurred in 1970 by the Department of Natural Resources and again in 1973. The Portage Canal Citizen's Group which formed in 1975 continued the cleaning of weeds and debris initiated by this department. The Portage Canal Society grew from this initiative in 1977 to guide the preservation and legal protection of the canal. As part of this goal, the society continued the "clean-up" program begun in 1975 (Kleist 1993: 28-29). The historical significance of the Portage Canal received formal recognition when it was entered onto the National Register of Historic Places in 1977 (Wisconsin Division of Historic Preservation 1977).

Because of the high level of encroachment on the canal property, a problem continuing from the 1890s, the state relocated the monuments set by the Army Corps in 1974. The United States had claimed ownership of the full 190' right-of-way along the canal. In 1979, the Portage Canal Society expressed concern about encroachment to the Citizen's Advisory Committee of Wisconsin. However, the attorney general concluded that since private property owners had encroached on the canal's right-of-way for over 100 years, the state possessed title to only the area between the canal banks. In 1981, Governor Dreyfus formally designated the Department of Natural Resources as the agency administering the state ownership of the Portage Canal and requested a certified survey of the property. Bridwell Engineering Company, Inc. of Madison completed this survey in 1983 and defined a right-of-way of 75 feet across the property (Kleist 1987: 31; WDNR, Facilities and Lands 1958-97 [file: Portage Canal, 1958-75]; Bridwell Engineering Company 1983; WDNR, Southern District 1946-92 [file: 1946-74: 1965 report by the Governor's Task Force; 12/18/70 WDNR memo; file 1979-82: letter dated 11/21/79 to Anthony S. Earl; file: 1982-91, 3/3/82 letter from Governor Dreyfus]). In 1982, the Army Corps also placed the Lower Fox Waterway in a caretaker status and completed documentation of the components of the property in 1995 (Richards 1995).

In 1985, the City of Portage, Columbia County, and the state signed a Memorandum of Understanding which took initial steps toward site preservation by coordinating efforts through the Fox-Wisconsin Heritage Waterway Park Corporation. Its purpose was to guide the preservation and maintenance of the Portage Canal, establish a historic park along the canal and a portion of the Fox corridor, enhance support for the project, and hold rights to the property. Essentially carrying out this mandate, the University of Wisconsin Extension, Portage Canal Society, and the City of Portage took steps to enhance the historic image of the property between 1984 and 1987 (Lenzi 1986). These activities included the construction of a rustic footbridge across the canal in 1984 to provide access to the business area for the senior citizens; the placement of horizontal timber revetments along the banks of the canal from Adams Street to the footbridge between 1986 and 1988 during the city's revitalization project; and the establishment of a canoe trail which entailed the addition of wooden piers to permit portaging around structures crossing the canal. Additionally, Section 3039 (9) of the 1985 Wisconsin Act 29 gave the Fox River Management Commission the responsibility for maintenance and rehabilitation of the Portage Lock between 1985 and 1987. A sum of \$30,000 was allocated for this purpose. Its allocation was subjected to the approval of the Fox-Wisconsin Heritage Waterway Park Corporation. Several inspections of the lock by Ross Plainse of the Army Corps of Engineers occurred during this period.

The 1985 park concept dovetailed with the proposed Fox-Wisconsin National Heritage Waterway Corridor initiative led by the East Central Wisconsin Regional Planning Commission beginning in 1989. To this end, General Engineering Company, Inc. of Portage, which had conducted a feasibility study for the re-opening of the Portage Canal in 1988, revised the study in 1991. The Portage Ad Hoc Committee on Flood Control was established in 1991 principally to guide the planning of the intersection of the levee structure with the mouth of the Portage Canal and to initiate feasibility studies for treatment of the historic site. In 1992, the city passed resolution No. 4417 favoring the placement of a narrow-gated structure to provide access to water flow through the levee designed to ring the mouth of the canal. As an interim flood protection measure, the Department of Natural Resources placed a temporary levee across the mouth of the canal in 1992. That levee remained in place in 1998 (East Central Wisconsin Regional Planning Commission 1948-85 [file: Heritage Waterway Park, 1985]; Kleist 1987: 31; Portage Ad Hoc Committee on Flood Control 1992: 1, 10-15; WDNR, Southern District 1946-92 [file: 1982-91, memo 4/9/87 from Larry Freidig]; WDNR, Facilities and Lands 1958-97 [file: Portage Levee, 1992]; Foellmi 1997).

THE STRUCTURES SPANNING THE PORTAGE CANAL

Beginning in 1850, vehicle and railroad bridges and much later culverts and footbridges spanned the canal. These structures provided access across the canal between the north and south portions of the City of Portage. Additionally, several major thoroughfares which linked Portage to its hinterlands crossed at these points. As a trade center serving the adjacent rural areas by the 1840s, Portage's businessmen depended on the accessibility of Portage to rural residents. Varying with the quality of the road, reasonable hauling distances

were limited to about fifteen miles. Later, poor roads limited the radius served by cheese factories and creameries which depended on frequent milk deliveries to three to five miles (Schaffer 1922: 74). These farmers supported Portage's economy by relying on its commercial services and crafts and purchasing supplies in its retail district.

These major routes which crossed or ended at the canal included the Military Road constructed between 1834 and 1837. It provided a major access route to Portage to the northeast and south during Portage's early development. To facilitate local travel, Webb and Bronson who platted southeast Portage in 1849 completed "a turnpike road" across the Portage in 1850 (River Times 1850 [11/4: 2/2]). Probably built as a state road by 1849, the Old Pinery Road, now current West Wisconsin Street in and adjacent to Portage, led northwest from Portage toward the Pinery (Butterfield 1880: 439). The New Pinery Road traveled directly north from Portage along the path of STH 51 by ca. 1853 (Wisconsin State Register 6/13/74; Butterfield 439, 598; Haslam and Abbott 1855).

The Fort Winnebago and Duck Creek Plank Road connected Portage to its southern hinterlands over the Duck Creek Marsh. Less expensive to construct than the railroad and utilizing private conveyances, plank roads initially appeared to be the solution to medium-distance travel between urban centers. Between 1846 and 1871, the territory and state chartered 135 companies formed to build plank roads and turnpikes (Wyatt 1986 [vol 2, sec. 2, transportation]: 7; Nesbit 1973: 200; 1985: 142-43). The state chartered the Fort Winnebago and Duck Creek Plank Road Company in 1850, and Henry Martin surveyed the route of the Plank Road in 1851. The 20' wide, four mile road originally ran south along E. Wisconsin from the south end of the Wisconsin Street canal bridge. A small cluster of hotels and taverns first emerged to serve traffic associated with the logging industry along the Wisconsin River in the 1840s and remained at the intersection of the canal and E. Wisconsin Street or the Plank Road until the 1880s (Sanborn-Perris Map Co. 1884; Ft. Winnebago and Duck Creek Plank Road Company 1851-74 [1871 survey]). The plank road company completed the road which travelled south along the Wisconsin River probably to the south side of the bridge which crossed Rocky Run Creek between 1851 and 1856 (Fort Winnebago and Duck Creek Plank Road Company 1851-74; Harrison and Warner 1873).

In 1850, the Wisconsin legislature authorized the Board of Public Works to enter into contracts to construct bridges "with the necessary draws" across the Fox and Wisconsin rivers and the Portage Canal as needed (Wisconsin, State of [Laws] 1848- [1850: 48-49]). On May 20, 1850, Thomas Reynolds signed a contract with the board to erect a swing or draw bridge across the crib work of the Portage Lock, and Nelson McNeal erected a similar bridge across the Fort Winnebago Lock. The work reached completion by January 1852, after a short period of contract suspension when the board lacked the funds to support the project (Green Bay and Mississippi Canal Company 1848-1909 [Board of Public Works 1848-53, vol. 5: 192-93, 206]).

With the requirement that the Board of Public Works review the plans, the legislature permitted the Town of Winnebago to build three bridges across the canal near the Indian Agency House, at the Center Avenue, and either the Main,

Adams, or Wisconsin street crossings in 1851. The bridges specified in this legislation were not immediately built. Since at least two of these bridges were not built, the legislature instructed the board to contract for the construction of draw bridges at the Main Street or Pinery Road, the Wisconsin Street, and Center Avenue crossings over the canal in 1852 (Wisconsin, State of [Laws] 1848-[1851: 280; 1852: 342, 575, 612-13]). Charles S. Hawley of the Town of Waukesha contracted with the board to build three wood float bridges at the three above locations across the canal between December 25, 1852 and July 1853. Bridges appear at Wisconsin and Center streets by 1861. It is not known whether the bridge near the Indian Agency House was ever built (Wisconsin Governor 1840-1914 [1852-53: folder 8, box 9]; Green Bay and Mississippi Canal Company 1848-1909 [Board of Public Works 1848-53, vol. 2: 29-30, 65]; Ligowski 1861).

By 1873, vehicle bridges continued to cross the canal at the juncture of Wisconsin and Oewitt and at the Center street crossing (Harrison and Warner 1873) (see WI-104-33 and figures a-d for street locations). In 1876, the draw bridge at Wisconsin Street received new planking by the Army Corps. The float bridge at Ketchum's Point or Center Street may have been removed by 1876 and replaced by a temporary trestle bridge. In 1880, the City of Portage replaced the bridge at Center Street with an iron swing supported by a masonry substructure. When drawn, the bridge provided a horizontal clearance of 60'. The city replaced the bridge removed by the Army Corps from the Wisconsin Street crossing in 1879. In 1878, the district engineer's office at Milwaukee had provided plans for the bridge abutments. The draw bridge had stone abutments which probably supported an iron superstructure. However, while the report of the Army Corps described an iron bridge, the Sanborn-Perris Maps of 1894 and 1899 indicated a wooden bridge. It provided a clear horizontal passage of 50' for the passage of boats. By 1901, an iron bridge was clearly identified and was replaced by a steel bridge in 1918. This bridge probably remained in 1929 (Sanborn-Perris Map Co. 1885-1929 [1894, 1899, 1901, 1910, 1918, 1929]; U.S. ACE [Report] 1839-1963 [serial 1845, H. Doc. 1, vol. 2, pt. 2, 1879: 1174, 1536-37; serial 1744, H. Doc. 1, pt. 2, vol. 2, pt. 2, 1877: 423; serial 1955, H. Doc. 1, pt. 2, vol. 2, pt. 3, 1880: 1968; U.S. ACE, Chicago District n.d., 1873-1928 [10/30/1878 plan, 13-H-11, tube 72/204]; Stoner 1882).

The City of Portage replaced one of the two vehicle draw bridges spanning the canal at Wisconsin and Center streets in 1928 with a high span bridge. The city and county provided one-half the funding while the state paid for the remainder of the \$100,000 bridge. The current STH 33 bridge crossing replaced the draw bridge at Center street. Construction began in October 1950, and the structure reached completion in November 1951. This low span bridge was designed to permit the passage of canoes and similar, low pleasure crafts but not commercial boats (Peters 1948: 8; Wisconsin Public Service Commission 1931-51 [1937, file C-42.141; 1954, file D-30.141]; Plaque, STH 33; Galley Studio 1950). The Army Corps provided permission for the city to built the present fill and culvert construction to replace the steel draw bridge crossing at Wisconsin Street in 1959. The city had added a similar fill and culvert crossing between Adams and Thompson in 1954. A bridge did not exist at this location prior to the culvert. This structure included an earthen fill of a 78' width extending across the canal between the two streets over a metal pipe culvert. The culvert measured 11'-6"

in diameter and possessed a clear height above the water of 4'-8". Provisions were made for putting small boats through the culvert with a hand line. Thus, the construction of the STH 33 bridge physically closed the canal to commercial navigation.

The construction of fixed bridges across the Fox Waterway received limited public comment at public meetings in 1949 and 1951. Objections came primarily from O.J.G. Peters who remained an active advocate of the improvement along the Fox and Wisconsin rivers (Mermin 1968: 156, 162-63; Register-Democrat 1936 [5/28: 5/6-8]; Madison Capital Times 1952). Since the Army Corps had closed the Fox Waterway to navigation in 1951 and was in the process of transferring the improvements to the State of Wisconsin, the obstruction to navigation by the low span, concrete bridge or the fill and culvert was no longer an issue. As the Army Corps began the transfer of the waterway to the state, the Public Service Commission which maintained jurisdiction over navigable waters in the state commented on projects that affected the canal. It determined that the fill and culvert project of 1959 did not interfere with navigation. However, the commission observed that there was no clear provision in the Wisconsin statutes for affirmative approval by the state of a municipal project involving the bridging of an artificial waterway. Its only legal response would be a negative decision if the action involved an unnecessary or unreasonable obstruction to navigation which was not warranted in this instance (Wisconsin Public Service Commission 1954-65 [1959, D-30.508, D-30.141¹⁸]).

Instead of acting as a feeder to the Fox-Wisconsin Waterway, the railroad dominated the transportation of passengers and non-bulk cargo along the Fox River corridor after the Civil War. Railroad bridges began to span the canal just as the Fox-Wisconsin Improvement Company was opening significant portions of the waterway to navigation in 1856. The Milwaukee and LaCrosse Railroad, later the Milwaukee, Chicago, and St. Paul, crossed the canal just north of STH 33 at the location of the surviving abutments in 1856. Sometime after this portion of the line was abandoned in 1907, the bridge was removed. Between 1864 and 1868, the Chicago, Milwaukee and St. Paul crossed the canal at its current bridge location south of Center Street. By 1868, the two railroad bridges were both iron lift bridges (Rugen 1868; Ligowski 1861; Portage Library n.d. [photograph]; Chicago, Milwaukee and St. Paul ca. 1944; Scribbins 1987a: 19-21; Jones 1914 [1]: 100-101; Brooks 1916). A new railroad draw bridge was constructed across the canal at one of two railroad intersections between 1870 and 1872 (Portage Area Chamber of Commerce n.d.). Providing support to the Fox-Wisconsin Waterway project and its improvement by the Army Corps in 1873, the Wisconsin legislature required that all railroad bridges crossing the Fox and the Wisconsin rivers follow guidelines regarding height and design specified by the Army Corps (Mermin 1968: 144).

In 1937, the Chicago, Milwaukee and St. Paul submitted a design to the Wisconsin Public Service Commission for the replacement of the lift bridge over the canal near Center Street, then known as bridge C-220. The railroad required a bridge

¹⁸ The text written 9/5/54 by George Steinmetz, Commissioner, cites sections 62.11(5) and 370.01(12) of the 1954 statutes for authority in his ruling.

capable of carrying greater loads to accommodate the increased weight of its locomotives. The commission examined the vertical and horizontal clearance of bridges affecting navigable waterways. The railroad constructed the 76' vertical lift, steel span bridge with 55' of clearance above the water in 1937. Portage contractor William Kutzke constructed the bridge following the 1936 design by the railroad in 1937 and 1938 (photograph WI-104-58). Built during an era when few large boats used the canal, the bridge was lifted manually only for inspections in 1938 and 1940. After the Army Corps of Engineers ceased to maintain the canal as a navigable waterway, the railroad removed the counterweights in 1952 and the bridge's superstructure in 1968. This bridge continues to span the canal (Wisconsin Public Service Commission 1931-51 [1937, file C-42.141]; Portage Daily Register 1/14/37; Columbia County Historical Society 1982; Portage Chamber of Commerce n.d.; Peters 1948: 8; Shank 1982: 49).

Finally, several footbridges have been erected across the canal. In 1963, the state quitclaimed land south of the Fort Winnebago Lock to the City of Portage. The city in turn leased the parcel to Portage Community, Inc. for fifty years in support of a civic project known as Playhouse Historique. The proposed project involved the construction of an outdoor theater. Although the theater did not materialize, a footbridge was constructed to provide access to the property shortly after 1965. The footbridge used the concrete walls remaining from the Fort Winnebago Lock as its abutments (figure d) (Wisconsin Public Service Commission 1954-65 [1965, file 017.36]). In 1984, a rustic footbridge was also constructed across the canal between Wisconsin Street and the Senior apartments just east of the Portage Lock. It provides access to the business area for the senior citizens (Portage Ad Hoc Committee on Flood Control 1992: 1, 10-15). As navigation of the Portage Canal by commercial boats ended in 1951, this function ceased to define the type of bridges which span the structure.

THE GROWTH OF PORTAGE ALONG THE CANAL

The Portage Canal runs along the base of a hill below its retail area just to the north (photograph WI-104-33). To the south of the canal lies a small industrial area. Portions of the two areas form two National Register districts, the Portage Retail District and the Portage Industrial Waterfront respectively. The Waunona Trail, a National Register Site running parallel to and south of the canal, marks the approximate location of the original portage between the Fox and the Wisconsin rivers. A small number of businesses emerged near Fort Winnebago at the east end of the portage, along the portage, and at the intersection of the portage and the Wisconsin River between the 1820s and the 1840s. But, most of Portage's retail, craft and industrial, and commercial enterprises developed along the west end of the canal and north of it in the current retail area beginning in the late 1840s.

Civilian settlement gradually increased at the portage after the government established Fort Winnebago at the east end of the portage in 1828. Along with forts Howard and Crawford, Fort Winnebago provided a line of military defense between the Great Lakes and the Mississippi River. Concern for English domination of the nation's northern boundary and, more immediately, for Winnebago

and Sauk and Fox reprisals and the provision of protection for the fur trade led to the fort's construction. John Jacob Astor maintained a trading post on the east side of the portage. The government positioned the fort to protect the portage, a strategic link for both military and civilian communications and trade. The Fox-Wisconsin Waterway and the adjacent Military Road merged at the portage. James Doty and Lieutenant Alexander J. Center of the Fifth Infantry completed their survey of the road for the Quarter Master General in 1833 (Center 1833). Thomas J. Cram eventually supervised the completion of road's construction between 1834 and 1837 (Clark 1908 [1879]: 309-10; Turner, A.J. 1898b: 66-67, 70; Smith 1973: 436-37; Larson 1979: 44).

The fort functioned as a community and served as an important point of contact between the Euro-American and primarily Winnebago communities. It was a small commercial center periodically receiving goods from Green Bay. The fort sutler and for a time Daniel Whitney provided goods to traders. When the troops withdrew to serve in the Mexican War, the army permanently abandoned Fort Winnebago. However, it and the area along the Wisconsin River remained the centers of the Portage community until the acquisition of the Menominee lands in 1848 (Kinzie 1948 [1856]; Merrell 1908 [1876]: 374; Turner, A.J. 1898b: 98; Wisconsin State Journal 12/13/1923; Powell 1978: 34-39; River Times 1853 [6/27: 1/6]).

In 1836, the Wisconsin Territory created Portage County which then included most of Columbia and parts of Dodge and Sauk counties. The portage, then in the Town of Winnebago, served as the county seat. Despite this designation, the portage remained unorganized as a platted community until 1849. After 1838 to 1841, Portage County appears to have had no legal county seat, and no permanent county seat was designated for the Columbia County until 1852. Columbia County legally received its lands in the Menominee Territory in 1851. The Town of Winnebago Portage which included the area south of the canal and a section of land north of the canal still nominally part of Menominee land became the Town of Fort Winnebago in 1850. Later the same year, the town's name was altered to the Town of Portage City. In 1852, it became the permanent county seat. The Town of Portage City was incorporated as Portage City in 1854. The city council altered the name to Portage in 1875 (Smith 1973: 204-206; Jones 1914 [1]: 80, 103-106; Butterfield 1880: 362-68, 378, 603-604; Turner, A.J. 1898a; 1904: 14-37, 73, 76).

Although almost all of the lands within the City of Portage were essentially not available for individual land purchase until 1852, three informal communities totaling about 200 residents emerged within or adjacent to it beginning in the 1830s. As noted, the earliest settlement gathered along the Fox adjacent to Fort Winnebago by the time of Henry Merrell's arrival in 1834. Portage's early retail and commercial services developed in this area. They included the later grain mill site (figure 8) located south of the Fort Winnebago Lock within the canal's right-of-way and leased by the Board of Public Works to Joseph Bulgar on January 1, 1853 (Bamberg 1866-1960 [folder 5, box 2 [copy of lease to Bulgar, 4/9/52]]). These businesses served both the civilians and military personnel as well as those working along the first canal in 1838. Few private dwellings besides the Indian Agency House and the Merrell House were built here. During the late 1830s and 1840s, a second community began in Ward One along the Wisconsin River, the

east end of Wauona Trail, and near the site of the first canal. This area included hotels, taverns, mercantile stores, warehouse, sawmill, and steamboat landing. By the 1850s and 1860s, the area just south of the canal from its mouth to Adams included one lumber mill, a tannery, foundry, and grain mill. Many of these commercial undertakings emerged to serve the lumber trade then developing to the north along the Wisconsin River.

The third community began along current Main Street and adjacent Cook in the late 1840s and became the nucleus of the current city. Retail enterprises in the late 1840s and early 1850s included the Veeder House first built in 1850 and replaced in 1860; the Old City Hotel; the mercantile stores of Smith and Wilson, C.J. Pettibone, and at least one other; a grocery; butcher shop; the drugstores of Carleton McCulloch and Best; a barber; tin shop; numerous law offices; and several taverns. A small number of houses were scattered along the hill around this retail district. The retail district later spread along Cook Street.

The community adjacent to Fort Winnebago declined in the mid-1840s when the military evacuated the fort. Not far from the main business district, the second community failed to develop as rapidly as the area along Main and Cook and eventually merged with it (Butterfield 1880: 430-32, 439, 589, 591-93; Portage Daily Register 8/19/1972; Wisconsin State Register 1874 [6/13, 10/13]; De La Ronde 1908 [1876]: 345-52).

Portage finally became a platted, incorporated community in the early 1850s. Benjamin Webb and Alvin Bronson, non-resident investors, purchased the 648 acre Claim No. 21 or the south portion of the current city. They directed John Mullett to survey the Webb and Bronson Plat of the Town of Fort Winnebago in 1849 which included the canal property. The Menominee lands were opened for settlement in 1851. In 1852, Henry Merton completed the Guppy plat which included the retail district and adjacent residential areas northwest of the canal north to Oneida, west to MacFarlane, and east to the canal in 1852 (Guppy 1852).

Settlement within the city limits began in the mid to late 1830s along East Wisconsin and in a few isolated locations northwest of the current canal well before the first plat of 1849. However, settlement remained sparse and temporary. The first unsuccessful attempts by the Portage Canal Company to excavate the Portage Canal in 1835 and 1838 attracted a relatively large, rather transient population. By 1850, the business corner at Cook and Main remained limited to an area east of DeWitt, south of E. Pleasant, north of the canal, probably west of Jefferson. The second effort to build the canal under the Wisconsin Board of Public Works beginning in 1849 produced a canal of limited utility. It did permit transportation of goods from Portage primarily along the Fox but also the Wisconsin. With access to trade centers, Portage became established as a community of limited size providing services to the logging region to the north (Schaffer 1937: 90, 93, 99-103; Mermín 1968: 25-49; Butterfield 1880: 436, 449; River Times 1851 [7/20: 1-2/1]).

The River Times of 1850 (1850 [11/4: 2/2]) reported that as the canal rapidly neared completion in the central business district,

Good buildings have been erected and are still going up at all seasons for a little over a year. The number built within that period is over two hundred. Among them are stores of all descriptions, mechanics' shops, taverns, offices, &c., &c.

Although the description is likely exaggerated, growth in both population, number of buildings, and amount of trade proceeded at a more rapid pace in the early 1850s than during the preceding decade (Wisconsin State Register 6/13/1874). With promise of railroad connections, expansion of businesses and small industries continued until the panic of 1857.

Railroad connections located along the north side of Portage by the Milwaukee and LaCrosse Railroad, later the Chicago, Milwaukee and St. Paul, were established in December 1856. The railroad began operation in 1857 and completed connections to La Crosse in 1858. By the 1860s or 1870s, Portage probably became a terminal point at which railroad crews were changed. Railroad repair shops as well as the usual commercial establishments operated by the railroad or private enterprise were also placed along the tracks in this area beginning in the 1860s (Portage Daily Register 5/19/36; Scribbins 1987a; 1987b). The Wisconsin Central connected Portage with Stevens Point in 1876. This branch also gave the railroad a more direct route to Milwaukee. The Wisconsin Central entered Portage from the northeast and curved south paralleling Michigan Street to Center where it turned east to connect with the Chicago, Milwaukee and St. Paul tracks near Wauona Trail in Ward One. Constructed in 1876 at the intersection of Superior and Center, the extant Wisconsin Central Depot received and dispersed both passengers and freight. The three stall roundhouse and turntable stood to the northwest of the depot between at least 1890 and 1927. The Soo Line absorbed the Wisconsin Central and operated what became known as the "P line" from Stevens Point to Portage in 1909 (Chicago, Milwaukee and St. Paul ca. 1944; Columbia County Historical Society 1982; Portage Daily Register 12/23/89; Milwaukee Journal 10/21/1945; Wisconsin Necrology, vol. 8: 180-86; Scribbins 1987a: 21; General Engineering Co. 1927; Foote, C.M. & Co. 1890; Rainey 1940: 193-195). Despite the arrival of the railroad in 1857, rapid business expansion was not immediate. The depression of the late 1850s and the Civil War checked development until after 1865.

By 1865, Portage served a growing rural farm population within a distance of about twenty miles to the south, perhaps as far as forty miles to the east and west, and fifty or more miles to the north. It had become a supply center for the north central Wisconsin lumber camps along the Wisconsin River. The city provided goods to settlements in the northern interior counties by 1860. Rapid commercial expansion filling vacant lots along Cook and DeWitt and spreading along West Cook from West Wisconsin to Lock Street occurred from second half of the 1860s into the early 1890s as Portage developed as a railroad and regional trade center (Wisconsin State Register 1863 [8/17: 3/1]; 1867 [5/4: 3/1]; Smith 1973: 188; Chicago, Milwaukee and St. Paul ca. 1944; Scribbins 1987a: 19-21; Butterfield 1880: 485-89; Jones 1914: 100-101).

Thus, the community of Portage began with a mixed, small retail, craft, commercial, and industrial area adjacent to the Fort Winnebago. In the late

1830s and 1840s, its retail center and craft businesses shifted away from the fort area to E. Wisconsin south of the canal and by the end of the 1840s to Main and Cook streets. In the same period, the community's industrial or large craft and commercial trade developed along the canal near Wisconsin Street. The canal allowed the movement of bulk goods to Green Bay. The retail and many of the smaller craft businesses slowly shifted to the expanding area along Cook and adjacent streets between 1849 and the mid-1850s, leaving the large crafts, industries, and commercial enterprises along the canal. The development of the lumber trade to the north stimulated the growth of Portage's commerce in the 1850s. Although not mutually exclusive, two distinct areas developed: the retail and small craft enterprises north of the canal and the small, local industrial or large craft enterprises along the canal. These industries included small sawmills and gristmills, foundries, a tannery, and a brewery. With its access to river ports on the Great Lakes and Mississippi provided by several local shipping companies along the canal as well as overland freighting to Milwaukee by 1852, Portage established itself as a regional retail and commercial center with a craft and small industrial base during the prosperous era of the 1850s prior to the depression of 1857 (Butterfield 1880: 588-89, 593; Jones 1914 [1]: 650; WPA 1938: 43-44; Wisconsin State Register 6/13/1874; Register-Democrat 12/19/1923; Democrat 2/30/1897: 1; Schaffer 1922: 130-32; Merrell 1908 [1876]: 368-71; Libby 1895: 310).

Between the 1850s and the 1880s, Portage developed as a regional retail and commercial center serving Columbia County and the region to the north. Few other major trading points served this region at that time. The city served as a supply and service point for the lumber industry operating along the Wisconsin to its north. Its commercial connections and small industries filled these needs and the requirements of the city and its rural hinterlands. Because the rivers flowing adjacent to Portage did not provide sufficient waterpower, the city did not become a major lumber or flour milling center but developed the commercial base to transport the lumber and wheat to milling centers along the Wisconsin River and Lake Michigan respectively. Much of the power which ran Portage industries utilized steam rather than waterpower. Since local capital supported the development of most of its crafts/industries, the city's industries remained small in size and value of production prior to the 1880s. Portage's industries processed such local products as wheat, lumber, hides, barley, and wool. In their early years, these industries were difficult to distinguish from large craft shops. As the development of the transportation network brought Portage's industries into competition with those in larger cities along the lakes and the Fox River Waterway, many but not all of these pioneer industries closed by the 1880s (WPA 1938: 50; Nesbit 1985: 149-59, 224; Smith 1973: 527-30, 534-36).¹⁹

Beginning in the 1880s, Wisconsin industry slowly specialized as growing urban populations created greater demands. An industrial setting replaced the early make-shift workshops. Portage developed an identification with a small number

¹⁹ The following section is taken from McKay 1992a and McKay 1992b, the two National Register nominations: Portage Retail District and the Portage Industrial Waterfront.

of major industries as did other mid-size Wisconsin cities. Now more standardized and used for long-range transportation, the railroad brought Portage in contact with sources of raw materials and markets far beyond its immediate hinterlands. It was no longer forced to provide a wide range of local crafts to its broad agricultural region; more standardized products could be acquired through wholesalers distributing goods manufactured in other urban areas. Still based on the manufacture of local resources, several industries such as the breweries, hosiery, stone monument, and furniture companies remained and expanded. A comparatively large number of small, often short-lived companies opened in the retail area. They continued to come and go well into the twentieth century. With several exceptions, the more substantial industries located primarily along or southeast of the canal.

The industries and commercial enterprises which concentrated in and near the canal and currently composed the Portage Waterfront District and some of the large firms in the retail area became the primary potential shippers of goods along the canal between the 1850s and the turn of the century. Some of these firms are identified below.

Portage's foundry and implement industry represents small to medium shops serving a local to regional demand. Such small concerns survived by reaching a local market and producing simple machinery. Several small implement dealers such as James Gowran between at least 1875 and 1897 or George Port who carried threshing machines, reapers, mowers, and drills in their warehouses in 1868-69 and 1870 served Portage but did not themselves produce implements. In 1860, three firms employing two to four hands advertised as fanning mill manufacturers, plow and wagonmakers, and founders. This number reduced to two in 1870. Portage and its hinterlands, then, supported a small number of short-lived foundries and related manufacturers until the 1880s when one company dominated the industry. Smith and Blair established a foundry along Dodge Street in 1853. This company employed twenty individuals and served a regional market in 1856. Perhaps developing from the later company, Dean and Smith, iron founders and manufacturers of threshing machines, produced 200 plows, fifteen threshing machines, and 2,000 pounds of castings. It employed fifteen individuals in 1860. Cromwell Brothers established a short-lived foundry operation known as the Portage Foundry founded in 1864. The foundry and machine shop of Fife & Co. and Davis and Vaughan, manufacturers of fanning mills, operated in 1870. In 1870, Samuel Vaughan produced 225 fanning mills and 100 milk safes with six employees. The Portage Iron Works became established along the canal between 1862 and 1865. Through the years, it operated primarily as a general jobbing and repair shop, a small establishment assembling parts both purchased and produced in-house in the manner typical of the times. By 1878, it manufactured chilled iron plows. Operated under different names, the company remained well into the twentieth century.

Portage businessmen established two woolen mills one of which became one of the city's major industries. Robert B. Wentworth and W.S. Wentworth and Loomis, Gallett, and Breese first promoted and organized the Portage Hosiery Company under a partnership in 1878. Construction of the mill began at 107 E. Mullett along the south side of the canal in 1880. Manufacturing its own yarns, the mill

first produced heavy wool sock for lumbermen as well as leggings and mittens. The business partners incorporated the Portage Hosiery Company in 1893. By 1897, the company employed 110 workers. The mill's physical plant gradually expanded along the canal in the 1890s until 1952 as its volume of production steadily rose. Through 1952, the Portage Hosiery Company manufactured men's and boys' mittens, boot socks, athletic socks, fine hosiery, and slipper socks.

Portage first achieved limited commercial importance by the early nineteenth century when it became a supply point for the fur trade. By the mid-nineteenth century, it gained its major distinction not only as a retail but as a commercial center serving Columbia County and the adjacent area in the northern pineries. Because farmers engaged in commercial agriculture almost immediately after settlement, they required outlets and sources of goods not produced on their farms. Wisconsin's small urban places created a limited demand for their goods in the 1850s. The pineries absorbed a large quantity of their products, and a growing amount was shipped out of Wisconsin. Without access to a railroad prior to 1856, products to and from Portage went overland or by the Fox Waterway toward cities along Lake Michigan. Arriving by 1856, the railroad carried an increasing number of goods to the lakes, particularly Milwaukee.

Although flour milling remained a relatively minor part of Portage's industry, grain dealers and later feed dealers played a major role in its economy. They bought, stored, and shipped the grain transported to Portage from its agricultural hinterlands and sold it to milling centers such as Milwaukee by the 1860s. Multiple flour and feed dealers existed in Portage after the mid-1850s, but most of their warehouses, feed mills, and offices no longer exist. In 1880, at least eight such dealers served Portage and its hinterlands. Andrew Weir operated as a grain dealer after 1855. Wells and Craig who operated the Portage City Mill remained dealers in flour and feed by 1869. Flour and feed dealer Daniel Wells remained in Portage during the 1870s. William Dates engaged in the flour and feed business in Portage after 1877. J.C. McKenzie became a wholesale and retail dealer in flour and feed by 1889. His enterprise included a warehouse and salesroom. George Craig's feed mill occupied a two story building at the southwest corner of Dodge and E. Wisconsin by 1889. H.A. Cuff purchased the McDonald and Tibbits steam powered feed mill in 1893. It once stood in the first ward at 214 East Wisconsin Street.

The growth of wheat as an important agricultural commodity in the 1840s and 1850s necessitated the development of facilities to store grain prior to processing, especially as processing moved away from the local communities to large centers. Robert B. Wentworth, a grain dealer, constructed the 40' x 60' and 50' high, timber frame grain elevator in 1862 southeast of the canal. Such timber frame elevators were once common in urban commercial areas. The Wentworth elevator now stands at 131 East Mullett. It possessed a storage capacity of 4000 bushels. By 1873 and no later than 1884, Wentworth, McGregor and Company operated the elevator. In addition, Wentworth established the Portage and Green Bay Transportation Company to move grain and freight along the canal and Fox River. His steamboats ran between Portage and Watertown, Berlin, and Green Bay between 1864 and 1873. A railroad side track extended to his elevator in 1871. His adjacent warehouses stored coal, seed, and lumber. Wentworth also purchased a

planing mill from the James Fife & Co. foundry in 1879. He processed his lumber products in the same building with his feed mill near his elevator. Wentworth probably sold this part of his enterprise to Oscar Van Dusen by 1884.

In 1889 and 1890, W.G. Gault and Sons owned Wentworth's feed mill. Irving W. York purchased the elevator about 1890. With his brother George E. York, he ran the Portage Roller Mills as: "...Grain Elevator and Grain Dealers, manufacturers of and dealer in high grades of wheat. Also proprietors of the Portage Electric Light and Power Company" (Polk, R.L. & Co. 1890). Sometime between 1918 and 1929, the company added the adjacent, one story, frame feed warehouse.

Like the feed mills and grain and flour warehouses, only a small number of Portage's warehouses storing dry goods, provisions, groceries, hardware, fruits, produce, and other commodities continue to stand. Typical for large, nineteenth century firms, several mercantile, grocery, hardware, and drug companies at Portage extended their retailed businesses by additionally maintaining a wholesale establishment. They purchased and shipped goods in bulk. In 1850, N.H. Wood and by 1867 Wood and partner L.H. Breese established a mercantile store which operated under the name of N.H. Wood and Company. In 1869, it had become Loomis, Gallett, & Breese which functioned as Wholesale and Retail Merchants. The business continued to operate until 1914. C.H. Pettibone and clerk Edward L. Jaeger established a mercantile store in 1850. By 1868 and 1869, Pettibone and Jaeger advertised as dry goods merchants, "Wholesale and Retail Dealers in Dry Goods, Notions, Groceries, Ready Made Clothing, Boots and Shoes, Hats and Caps, Carpets, Oil Cloths &c. DeWitt Street." Frederick W. Schulze and Gerhard Schumacher operated as the firm of Schumacher & Schulze, wholesale and retail dealers of general merchandise, from 1867 to 1869. In 1869, Ferdinand Schulze joined the firm which then became known as Schumacher & Schulze Bros. Between 1886 and 1890, it was known as Schulze & Co. and continued to operate as both a wholesale and retail cash department store or mercantile store. Its stock included dry goods, notions, clothing, carpets, boots and shoes, and hats.

An early groceryman in Portage, August Voertman ran his business from 1853 to 1878. In addition to his retail trade, Voertman also sold goods wholesale to lumbermen. Henry Bolting moved his stock into his new store on West Cook in October 1863. He operated as a wholesale and retail dealer in groceries, wines, liquors, and cigars. In 1874, J.E. Wells purchased the inventory of the Bacon estate. With partners P.J. Barkman and H.W. Williams, he began his hardware business. J.E. Wells & Co. operated by 1877 as "Wholesale and Retail dealers in General Hardware, Stoves, Farming Implements, and Manufacturers of Tin, Copper, and Sheet Iron Ware" (Merrill, Wood & Co. 1877). A druggist by 1867, John Graham advertised in 1867-68 as a (Farnham and Vivian 1867-68):

...Wholesale and Retail Druggist and Grocer. Dealer in Stationery, Yankee Notions, Fine Liquors, cutlery, Wall Paper and Crockery, Paints, Oils, Varnishes, Water Lime, Land Plaster, Builders' and Painter's Materials. Garden and Field Seed, Window Glass and Glassware. Agents for Mail, Steamship and Sail Vessels to all parts of the world.

Edmund S. Purdy, druggist, purchased his business in 1871. With partner Henry Merrell, he formed the drug company of Purdy and Merrell which in 1876 became the Purdy Drug Company. In 1877, Purdy advertised their business as "...Wholesale and retail dealers in Drugs, Medicines and Chemicals, Books and Stationery, Paints, Oils and Dye Stuffs" (Merrill, Woodard & Co. 1877). C.F. Mohr operated a general store by 1869 and located at 119 West Cook by 1883-84. The Mohr Produce Company grew from this business. The Mohr Company maintained a coal shed, coal bin, lumber and lime house, and implement warehouse along the southeast side of the canal after 1910 and before 1918.

Several buildings which served as warehouses continued to stand by 1992. Robert Cochrane established his business as a produce and commission merchant in 1877. At his death in 1910, Thomas H. Cochrane maintained the business and incorporated it as T.H. Cochrane and Company by 1914. The company maintained its main office in Portage and ran twenty-three branch offices in Wisconsin and Minnesota. With Leonard Hettinger, Cochrane also formed the Portage Wholesale Grocery Company which stored the company's products at 141 E. Cook between approximately 1924 and 1929. Cochrane also established a warehouse along West Edgewater and his office in the former State Register Building at the northwest corner of DeWitt and Canal by 1910. Neither of these locations remain. However, the massive seed and grain, concrete block warehouse erected between 1916 and 1918 stands at 114 Dodge.

Hence, by the late 1840s, Portage had become a region trade center serving its agricultural hinterlands as well as the lumber region to the north. Proprietors in Portage conducted a significant amount of commerce from establishments along and near the Portage Canal. It is known that commercial vessels utilized the Fox River and Portage Canal and relatively early the Wisconsin River between the 1850s and the 1880s. These vessels carried grain, feed, and lumber and probably transported limited merchandise, woolen goods, additional agricultural goods, coal, and other bulk products. However, exactly which individual businesses in Portage shipped or received goods via the waterway, when and what goods they were shipping by the waterway, and the quantities they shipped could not be determined during this study. Data which may partially address these questions may be contained in the records of the Green Bay and Mississippi Canal Company, the Fox and Wisconsin Improvement Company, and the Board of Public Works archived at the Area Research Center in the University of Wisconsin, Green Bay (Green Bay and Mississippi Canal Company 1848-1909).

COMMERCE ALONG THE PORTAGE CANAL

The supporters of the Fox-Wisconsin Waterway conceived of the route as a developmental waterway. Its construction for use by steamboats would facilitate the growth of agricultural and industrial commerce in the region into which it provided access. Its role as the major transportation route in the fur trade era and limited use for the shipment of lead into the 1840s suggested its future potential. Henry Dodge and Daniel Whitney had promoted the waterway for the shipment of lead in the 1830s (Clark 1955: 3-4; Libby 1895a: 306-08, 315). The Cram report of 1840 noted its importance for carrying lead, wheat and other

grains to eastern markets and transporting troops and their supplies (U.S. ACE [Report] 1839-1963 [serial 359, S. Doc. 318, 1840: 2-3]). To attract federal support even in the 1850s, the waterway had to achieve national importance for military and commercial use. Lying as it did between the Great Lakes and the Upper Mississippi River Valley, this importance as a national thoroughfare went unchallenged into the early 1870s.

Thus, the building of the Fox-Wisconsin Waterway with the Portage Canal as its connecting link began in 1849 with great expectations for its economic success. The success of the Erie Canal indicated for this waterway, as it had for many others, the amount of potential commerce which would eventually travel along it. In addition to assisting the settlement of the region, its importance lay in its capacity to provide an outlet for goods produced in Wisconsin and those states west of the Mississippi.

By 1870, the waterway also gained importance because its competition maintained the price of shipping goods by railroad. As early as 1868, Warren found that inexpensive water transportation would save producers and consumers millions of dollars in railroad freight rates. By the late 1860s and early 1870s, the focus shifted from transportation of all available goods to bulk agricultural and industrial products. Here, the railroad's competitive edge was less clear. And, the prodigious agricultural production in the Midwest would provide sufficient business for both forms of transportation. The joint resolutions by the Wisconsin legislature in the late 1860s and early 1870s as it sought federal assistance for the waterway's continued development emphasized the importance of Warren's statement. It found insufficient transportation facilities to move agricultural products, and the cost of shipment remained so high that the producer realized little profit (U.S. ACE [Report] 1839-1963 [serial 1368, H. Doc. 1, pt. 2, 1869: 52, 357-58; serial 1598, H. Doc. 1, pt. 2, 1874: 218-19, 222-23]; Schaffer 1937: 108, 272-89; Whitbeck 1915: 33; Clark 1955: 7-8; Wisconsin, State of [Laws] 1848- [1864: 561-62; 1865: 696-97; 1867: 209; 1868: 232; 1869: 269; 1875: 678-79; 1885: 506-08]; Wisconsin, State of [Journal of Proceedings] 1848- [1867: 21-22; 1869: 282]; Meindl 1991: 36).

Shipping along the Fox Waterway occurred along short segments of the improvement during periods of high water by the mid-1850s. While steamboat arrivals at New Orleans began by 1811 and along the Upper Mississippi River by 1823, steamboats did not usually travel along canals until the 1850s (Vogel 1993: 15, 41-43; Merritt 1979: 28-29; Armstrong 1976: 46). However, steamboats were found along Lake Winnebago by 1845. The John Mitchell coming from the Fox River and the Enterprise arriving from the Wisconsin River were unable to pass each other within the Portage Canal in 1851. Shallow draft steamboats such as the Enterprise, Berlin, and Princeton operated along the Wisconsin from, for example Galena, to Portage during the early 1850s. A steamboat ran between Berlin on the Upper Fox and Lake Winnebago by 1853. Up to six steamboats ran periodically between Green Bay and Kaukauna in the early 1850s. Daily trips occurred between these two points in 1854. The Fox and Wisconsin Improvement Company had achieved sufficient improvement in river depth by 1856 to permit the operation of small steamboats such as the Aquila, which navigated the entire length of the waterway between Green Bay and Lake Winnebago.

Navigation along the entire Fox Waterway began sporadically in 1858. By that date, five steamboats ran along the Upper Fox River between Lake Winnebago and Omro and Eureka. By 1858, G.K. Warren observed that steamboats made regular trips daily from Green Bay to Oshkosh and from Oshkosh to Berlin. For part of the navigation season, they operated between Berlin and Montello with occasional trips to Fort Winnebago (Meindl 1991: 36; Schaffer 1937: 107; Whitbeck 1915: 31-32; River Times 1853 [2/21: 2/3; 1/23: 3-4]; Childs 1906 [1855]: 183; U.S. ACE [Report] 1839-1963 [serial 1744, H. Doc. 1, pt. 2, 1877: 224]; Vogel 1993: 42-44; Fox and Wisconsin Improvement Company 1859-62 [1862: 6]).

By 1852, the Board of Public Works invested considerable capital straightening portions of the Upper Fox to permit the shipment of lumber to the Wisconsin River. Lumber was a primarily commodity shipped along the Upper Fox Waterway in the 1850s. Even then, lumbermen divided their load about one mile from Portage. The board established a schedule of tolls charged at the locks by 1853 and designated a lock tender. It set rates for a wide variety of goods including flour, grain, livestock, wood, wood products, brick, and lead which might leave Wisconsin and general merchandise, machinery, iron, mill stones, and processed foods and other provisions shipped to the valley. It anticipated the use of the waterway by both steamboats and durham boats in this early period (Green Bay and Mississippi Canal Company 1848-1909 [Wisconsin Board of Public Works 1848-53]).

The currently available records summarizing the commodities transported along the Fox Waterway usually failed to indicate the shipping points from which or to which the goods were traveling. For example, the 1859 report of the Fox and Wisconsin Improvement Company segregated the commerce going upstream and downstream and indicated the type and amount of commodities for 1858. However, the amount of this traffic originating at or shipped to Portage was not documented. Of the fifty-three different items listed, logs, boards, and planks were the dominate items shipped in both directions along the waterway. The upward shipment of lumber which was probably destined for the Wisconsin and the Mississippi river markets through the Portage Canal totalled 3,922,767 board feet while the downward shipment contained 2,577,703 board feet. Horse boats, which indicate the use of a towpath along a portion of the Fox Waterway larger than the Portage Canal, and scows carried the lumber along the Upper Fox to the Wisconsin River. In 1851, the mills along the Fox and Wolf rivers produced approximately thirty million board feet (Wisconsin Board of Public Works 1848-53 [1852: 84]; Schaffer 1937: 107-08; Nesbit 1973: 208).

Also in 1859, wood products; sandstone, lime, and clay which was measured by weight; agricultural products such as butter, wool, wheat, oats, bran, and fruits; and manufactured products such as flour, furniture, castings and ironware composed most of the material probably being shipped from the valley (Fox and Wisconsin Improvement Company 1859-62 [1859: 10-11]; U.S. ACE [Report] 1839-1963 [serial 1744, H. Doc. 1, pt. 2, 1877: 225]). Large amounts of building materials including stone, lime, brick, sand, and gravel typically moved along the waterways by the late 1850s. Given their weight and bulk, railroad shipment, if available, often became too expensive (Taylor 1951: 171). A comparative study of amounts being shipped along contemporary Midwest waterways such as the Illinois and Michigan Canal may indicate the significance of shipping along the

Fox Waterway for regional trade.

The period of greatest commerce along the Fox Waterway occurred in the 1860s and 1870s as settlement along the Upper Fox Valley expanded rapidly. In the 1860s, shipments between Fond du Lac and Oshkosh and the lower Mississippi through Portage transported flour, logs, shingles, and other wood products. Between the 1850s and the 1870s, the Fox-Wisconsin Waterway continued to carry a considerable number of lumber rafts from the Wisconsin and Wolf rivers which were being carried east and west through the canal. The improvement company recognized the railroad which ran through Portage and through Fond du Lac, Oshkosh, Neenah, Appleton, and Green Bay by 1862 as a sharp competitor for the carriage of wheat and flour. It projected that it would ship one-half the grain produced in Calumet, Winnebago, Green Lake, Marquette, Waushara, Columbia, and Sauk Counties from Wisconsin in 1863 (Fox and Wisconsin Improvement Company 1859-62 [1862: 7-8]). While Warren reported almost no traffic on the Wisconsin River in 1868, he noted the use of the Upper Fox waterway by steamboats, tugs, and barges carrying primarily lumber, coal, and grain. A year earlier, he had indicated that "The country between Berlin and Portage is almost entirely dependent on the river for transportation" (U.S. ACE [Report] 1839-1963 [serial 1278, S. Doc. 16, 1867: 25; also serial 1845, H. Doc. 1, pt. 2, vol. 2, pt. 2, 1878: 1169-72]; Mitchell n.d.: 206). At this time, he recommended the development of a slack water system along this portion of the Fox to provide sufficient depth for vessels using the system (Wisconsin State Register 1867 [6/29: 3/1]; Jones 1914 [1]: 632; Merrill 1919: 21-22; Mitchell n.d.: 205; Wyatt 1986 [vol 2, sec. 2, transportation]: 2).

Steamboats carrying these commodities along the Upper Fox became more numerous and began to maintain regular schedules in the 1860s. During 1862, the citizens of Portage ran a steam tug and two barges regularly from Portage, carrying a total of 10,841 bushels of wheat and 5,816 barrels of flour from the city. This may be the same line formed by R.8. Wentworth in the early 1860s. The Portage and Green Bay Transportation Company operated steamboats and barges between the two cities. This company probably owned the Portage which pulled barges out of Portage and then travelled between Green Bay and Portage between 1862 and the 1890s. General Warren also noted the regular operation of the L.W. Sargent between Portage and Green Bay in 1867. These two boats each carried sixty tons of cargo each season. Also owned by R.8. Wentworth, the Granite State operated out of Portage and ran between Portage and Green Bay between 1865 and 1895. The Winneconne ran along the Upper Fox to Portage between 1866 and 1869 when it was sold to the Army Corps for operation as a dredge on the Wisconsin River.

Facilities built to handle bulk commodities transported along the waterway began to appear in this period. In 1862, a warehouse and grain elevator, perhaps the Wentworth Elevator, were erected along the bank of the canal. Along the Upper Fox, warehouses and elevators were also built at Packwaukee, Oak Plain, Montello, Marquette, and Berlin in 1861 and 1862 (Fox and Wisconsin Improvement Company 1859-62 [1862: 5-7]). The rapid rise of commercial agriculture based on wheat and the processing of local resources such as flour, lumber, and wood products and somewhat later woolen milling and the production of building stone along the upper river required transportation to growing industrial areas along the Lower Fox and to eastern markets (Whitbeck 1915: 34; Meindl 1991: 10-11).

When the Army Corps assumed management of the Fox Waterway in 1872, the agency began its reconstruction of the waterway to accommodate light draft commercial vessels with a maximum depth of 6'. The agency found that reconstruction of the Fox Waterway for the large lake steamers was not economically feasible (Meindl 1991: 36). In 1873, the Army Corps noted that weight and bulk had begun to divide the kinds of goods taken along the canal and the railroad (U.S. ACE [Report] 1839-1963 [serial 1588, S. Doc. 307, 1874: 62]):

There appears to have been in the very beginning of rail competition a falling off in the carriage on canals of light and valuable articles requiring quick movement, while the carriage of grosser freights, in which the chief element incidental to commercial exchange is the actual freight-charges imposed, exhibits a steady and regular increase.

Because of the inadequate capacity of both modes of transportation to carry goods from west to east especially during the summer and fall seasons when canals were operative, the Army Corps undertook the improvement of the Fox-Wisconsin Waterway to provide a more reliable system. The Army Corps sought to maintain shipping at all stages of water. During the 1870s, the main product shipped east was grain and those going west from the Fox Valley were lumber and iron (U.S. ACE [Report] 1839-1963 [serial 1588, S. Doc. 307, 1874: 228; serial 1904, H. Doc. 1, pt. 2, vol. 2, pt. 2, 1880: 1532]).

By the early 1880s, attempts to develop improvements on the Wisconsin River came to a halt and would be abandoned by 1886. After 1884, the Corps continued to improve the waterway based on its use by local communities, its actual function up until this decision by the Army Corps. The project depth along the Upper Fox had reached 3' of its then planned 4' depth. The 1884 report by the Army Corps noted that: "The freight business is large and would increase very much if those interested could be assured that a navigable channel would be kept open" (U.S. ACE [Report] 1839-1963 [serial 2280; H. Doc 1, pt. 2; 1885: 1931, also 2044-45]). The waterpower of the Lower Fox River permitted considerable industrial development beginning by the 1870s. During much of the remainder of the century, the industrial development resulted in a comparatively substantial amount of commerce along this portion of the river. The limited power produced by the slow-flowing Upper Fox supported insufficient industry and trade to maintain significant commerce along this stretch of the river very long after the establishment and operation of a railroad network.

Developing a broad base of large craft shops and small industries and commercial trade in this period after the Civil War, Portage represented the largest city along the Upper Fox and the first of these cities to receive railroad connections. From or through Portage came primarily grain, timber, wood products, and woolen products. Small industries which served a limited area such as cranberry processing, granite quarrying, woolen mills, an iron foundry, a cabinet factory, a brewery, cigar factories, and an overall factory and warehouse storage for wholesale businesses emerged in Berlin, Montello, Omro, and Princeton. For a short period, some of these products, primarily those from Princeton, were shipped down the Fox. Lumber, coal, and grain also remained the

major commodities transported along the Upper Fox in the late 1870s.

An analysis of the tonnage and board feet of lumber developed by the Army Corps for the Upper Fox between 1880 and 1882 revealed that by comparison with Eureka located near Lake Winnebago, the tonnage going through Fort Winnebago and Portage and the remainder of the Upper Fox system showed significant variations. While 84,000 and 97,000 board feet moved through Eureka in 1880 and 1882 respectively, 19,000 and 1,956,000 board feet were locked through Fort Winnebago Lock and 1,562,614 and 4,152,998 board feet moved through the Portage Lock in the same years. In 1881, 1.956 million board feet also went through the Governor Bend Lock. Then, while the amount of lumber going through the other locks along the Upper Fox was almost negligible with several exceptions such as the Governor Bend Lock, the number of board feet traveling through the Portage Lock was considerably greater in 1881 and 1882. Lumber was going from a point above the Portage area primarily to Portage. In 1883, these totals fell drastically, signaling the close of these milling operations. This amount was reduced to 285,000 board feet at the Portage Lock and 5,000 board feet at the Fort Winnebago Lock in 1883 (U.S. ACE [Report] 1839-1963 [serial 2280, H. Doc. 1, pt. 2, vol. 2, pt. 3, 1885: 1934-35]). Thus, into the early 1880s, while the total amount of tonnage had already begun to decline, a considerable quantity of lumber continued to go through the Portage Canal.

After the lockage of the Boscobel which was a government boat and the first steamboat to travel through the newly refurbished canal in 1876, relatively large craft of 300 ton capacity used the canal. Between 1876 and 1905, steamboats continued to carry such freight as lead ore, lumber, logs, other building materials, coal, stone, lime, clay, and agricultural products, especially grain. Others carried only passengers, and many carried both. Although some of the steamboats passing through the Portage Canal are identified, the regularity of trips by steamboats used along the canal during the 1870s into the early twentieth century is generally not known.

Identified vessels which periodically used the Portage Canal included the following: the City of Portage, Boscobel, Fox, Winneconne, Ellen Hardy which ran along the Upper Fox and Wisconsin beginning in 1870, the tug Dekorra which locked through the canal with some regularity by the late 1870s, the Neenah which was used on river repairs by the Army Corps between 1873 and 1925, E.P. Weston travelling the Upper Fox beginning in 1868, Yawl, Dart, Perkins, Solomon Leach, Black Hawk, George Lacy, City of Berlin which operated from Green Bay to Portage between 1889 and 1896 and the Grand and Rapids both of which operated along the canal and onto the Wisconsin River during the first decade of the twentieth century. By 1878, the Gussy Girdon which was built on the Wisconsin River ran on a regular schedule between Berlin and Portage, and other commercial vessels travelled between points on the upper waterway as needed. By 1884, three steamboats with barges in tow regularly travelled along the Upper Fox above Berlin. An additional vessel was confined to the stretch between Oshkosh and Berlin area. Again, additional boats ran periodically along the system (Meindl 1991: 38, 55; U.S. ACE, [Report] 1839-1963 [serial 2280, H. Doc. 1, pt. 2, vol. 2, pt. 3, 1885: 1928]; Mitchell n.d.: 207). In 1890, the Portage City and Green Bay Line navigated the waterway and the adjacent portion of the Wisconsin River.

Lockage count recorded a high percentage of pleasure craft even in the late nineteenth century. In the 1870s and 1880s, excursion boats also became popular along some of Wisconsin's large inland waterways including the Fox-Wisconsin (Jones 1914 [1]: 632; Merrill 1919: 21-22; Kleist 1987; Mitchell n.d.: 205-208; Portage Public Library n.d., 1909-10 [photograph, 1909]).

By the 1890's, although it is known that commerce along most of the waterway had fallen considerably, no comparative base exists prior to this period to indicate the amount of decline. With an average annual lockage total of 12,634 for the waterway in the 1890s, the average total at the Fort Winnebago Lock was 185 while that at the Portage Lock numbered only fifty-one. Much of the 389,291 tons of commerce for the waterway, 73 percent, remained logs, lumber, cordwood, pulpwood, and wood products. Coal, stone, brick, and other building products composed much of the remainder of the total. Only a small amount of agricultural products, primarily grains, moved by the waterway by 1890 (Whitbeck 1915: 36-37; U.S. ACE [Report] 1839-1963 [serial 2832, H. Doc 1, pt. 2, vol. 2, pt. 3, 1890: 2377]). The precipitous drop in commerce which occurred along the Lower Fox in the 1890s was probably principally caused by the depressed economy of the decade. By about 1900, no significant commercial traffic existed between Portage and Montello. Boat traffic included the Army Corps itself and a small number of pleasure craft. The railroad now carried most of the bulk goods such as agricultural products and coal. However, the Army Corps report concluded that, in principle, the upper waterway played an important role in maintaining the railroad freight rates at reduced levels. However, it did not quantify the amount of this reduction (Meindl 1991: 39; Portage Daily Register 1910 [1/8: 3/4]; U.S. ACE [Report] 1839-1963 [serial 2925, H. Doc. 1, pt. 2, 1892: 2573; serial 3299, H. Doc. 1, pt. 2, 1895: 2105]).

By the second decade of the twentieth century, the Army Corps and private businesses had developed boating and dock facilities. They likely existed well before this period, but documentation was not found. In 1919, most of the identified facilities were recorded for Lake Winnebago at Oshkosh. Thirteen wharves serving a variety of purposes occurred at this location. For communities between Lake Winnebago and Portage, these same records identify fourteen wharves for freight and passengers, lumber, and building materials. The 1921 report located these small docks at Montello, Princeton, Berlin, Eureka, and Omro. The lock walls were also used for the transfer of cargo and passengers (Meindl 1991: 38; U.S. ACE [Report] 1839-1963 [1919 [pt. 2]: 1486-87; serial 8005, H. Doc. 146, 1922: 25, 42]).

At Portage, the Sanborn-Perris maps dating between 1885 and 1918 illustrated warehouses and storage sheds associated with the lumberyards and planing mills, the hosiery and woolen mill, the grain elevators, iron works, and implement dealers with direct access to the canal. Several photographs dating between 1905 and 1915 indicated a narrow dock to which small boats were tied along the edges of the canal in the business district. However, neither the maps or photographs indicated wharves adjacent to these businesses. It appears that structures for unloading boats along the canal were quite minimal. The Portage Lock where some transfer of cargo may have occurred was located at the west end of the business district (Sanborn-Perris Map Company 1885-1929 [1885, 1889, 1894, 1901, 1910,

1918]; Stoner 1882; Portage Library n.d., 1909-10; Wisconsin Visual Archives 1855-1947, n.d. [photographs, n.d., 1905-10, 1915]).

Attempts to maintain a regular shipping service on the upper river above Berlin were abandoned about 1900. Tonnage along the entire Fox River system which dropped precipitously during the severe economic reversal of the 1890s never recovered in the twentieth century. If the total commerce for 1890 and 1914 is compared, there is a drop from 389,291 tons to 134,638 tons or a 65 percent decline (Whitbeck 1915: 37; Bambery 1860-1966 [folder 2, box 4, p. 87]). The reduction in the number of saw logs shipped along the river added to the decline of commerce at the turn of the century. By 1905, although several gasoline launches were counted, a majority of the boats received at the Fox locks continued to operate by steam.

In 1910, the primary traffic included occasional steamboats, gasoline launches, other pleasure craft, and government boats which maintained the waterway. Pleasure boats, principally gasoline launches, had become relatively common on the Upper Fox. This single use doubled the lockage between 1900 and 1915 along the waterway on this segment of the river. However, the lockage even in this period varied widely between locks. By 1915, one small steamboat made relatively regular, daily trips along the Upper Fox River principally between Omro and Berlin. A total of fifteen steamboats, seven tow barges and scows, and six registered gasoline launches operated periodically along both sections of the Fox in this year. Their combined tonnage equalled 1,914, and together they carried 149,872 tons. Coal at 84,690 tons was the principle load on the river. On the Lower Fox, building materials such as brick, stone, lumber, shingles and lathe, cement, lime, sand, and gravel; grain, flour, and feed; sugar beets; beer; butter; and general merchandise composed most of the tonnage in the second decade (Whitbeck 1915: 37-38; Larson 1979: 180; Vogel 1992: 95; U.S. ACE [Report] 1839-1963 [1910 [pt. 2]: 2136, 2138; 1914 [pt. 2]: 2914]).

The total tonnage along the Fox Waterway stabilized and began increasing between 1914 and 1918 when it rose to 165,936 tons. By 1921, it reached 285,590 tons, and by 1923 it had returned to 300,000 tons, 25,000 tons less than the 1900 level. Tonnage rose slightly for the rest of the 1920s and early 1930s. By 1918, tonnage on the Fox River system principally included 69 percent coal, 27 percent building materials, and 4 percent farm and dairy products. This rise in tonnage, coincident with the move to provide a deep channel along the entire Fox system, occurred on the lower river while little traffic resumed along the upper river. In 1918, the Upper Fox carried 321 tons (Meindl 1991: 39; U.S. ACE [Report] 1839-1963 [1921 [pt. 2]: 1038]; Bambery 1966-1960 [folder 2, box 4, p. 150]).

Lockage records available for the years between 1897 and 1918 indicated that the Portage Lock was the least used along the Fox Waterway while those recorded for the Fort Winnebago Lock rose after 1904. Hence, traffic, overwhelmingly passenger traffic, was going down the Fox rather than the down or from the Wisconsin. The annual lockage at the Portage Lock for the twenty-year period averaged 127, while those for the Fort Winnebago Lock reached an average of 1,126. In 1899, only fifty-five vessels were counted at the Portage Lock. The

lockage at Fort Winnebago between 1897 and 1904 was low, in the 100's or 200's. In 1899, for example, 203 vessels passed through the Fort Winnebago Lock. After 1904, it rose considerably. Between 1904 and 1905, the lockage at the Fort Winnebago Lock jumped from 581 to 1,145. At the Portage Lock, it remained relatively low in 1905 and 1908, at 107 and 186 respectively. By 1908, the lockage at Fort Winnebago reached 2,461. The Fort Winnebago Lock then became one of the most frequently used locks along the Upper Fox. Ten years later in 1918, the Army Corps reports noted a lockage of only 774 and 2,933 passengers at Fort Winnebago and a lockage of 119 and 257 passengers at Portage. And, the report noted a low amount of freight for these two locks (Meindl 1991: 27-28; Bambery 1866-1960 [folder 1, box 4, p. 116, 176, 296-97, 411]; U.S. ACE [Report] 1839-1963 [serial 4093, H. Doc. 2, pt. 5, 1900: 3715; serial 4787, H. Doc. 2, 1904: 2847; serial 4947, H. Doc. 2, vol. 7, 1906: 2049]).

The examination of the amount of commerce on the Upper Fox by the Army Corps led it to conclude by 1922 that maintenance of navigation facilities was no longer economically practical. During the early 1920s, commerce continued to fall. The total amount of commerce in 1920 was reduced by half compared with the level in 1915. The railroad had absorbed even agricultural products, coal, and lumber, the mainstay of its commerce. In 1920, commerce on the Upper Fox was limited to 850 tons. This tonnage represented the shipment of wire glass between Berlin and Oshkosh and coal used by the Army Corps dredge boat above Princeton. Efforts to use the improvement to transport milk between collection stations and the condensary proved unsuccessful, and trucks absorbed this commerce. On the Lower Fox, commerce had fallen to 20,000 tons in 1920. Every two to three years, a vessel was transferred along the waterway between Lake Michigan and the Mississippi during high water. Locally in 1920, the Army Corps recorded eleven tons of goods and 355 passengers through the Portage Lock and no tonnage but 1764 passengers at the Fort Winnebago Lock. In addition, Nehls Boat and Furnace Works shipped boats to the Wisconsin Dells through the Portage Lock in the early 1920s. Almost all of the lockage represented pleasure boating in small gasoline launches which itself was declining by 1920.

From these data, the district engineer determined that a rise in commerce along the Upper Fox appeared very unlikely. Industrial plants were constructed away from the river. Few markets existed along the river, requiring the transfer of goods to other means of transportation at both ends of the trip along the waterway. In many cases, the railroad or trucks carried the goods directly from and to their points of destination. Finally, the distance from any point west of Berlin by water to Green Bay was greater than the distance from those points by rail to Milwaukee which offered larger markets for the goods. Since the cost of maintenance and operation of the Upper Fox was about \$30,000 for 850 tons of goods, the district recommended the abandonment of the facility in 1921 (U.S. ACE [Report] 1839-1963 [1921 [pt. 2]: 1038]).

Commerce peaked along the lower river at 325,000 in 1932, the approximate tonnage recorded at 1900. Even along the lower river this traffic was local, traveling an average of 33 miles per haul. Heavy cargo, coal and sand, comprised the bulk of the shipments. Even though the rate per ton was 63 cents along the river as opposed to \$1.37 on the railroad, the tonnage along the river continued to

decline for the same reasons provided in the 1922 Army Corps report (Vogel 1992: 95-96; 1993: 57; U.S. ACE [Report] 1839-1963 [1921 [pt. 2]: 1038; serial 9564, H. Ooc. 212, vol. 3, 1932: 2, 11, 13]).

Through the 1930s, the vessels passing through the Upper Fox locks were small pleasure boats. The regular freight and commercial passenger boats ceased operation in 1921 along all of the river. Tonnage on the Upper Fox ranged from twenty-nine in 1925, peaking in 1927 at 742, and descending again to fifteen tons in 1930. In 1927 and 1928, materials associated with road building were hauled along the canal as a road was completed near Berlin and Eureka. By 1950, the year before the Army Corps closed the upper system, boat traffic on the Upper Fox was composed entirely of recreational vessels such as canoes, skiffs, rowboats, motorboats, and houseboats. While eight vessels passed through the Portage Lock, thirty-one went through the Fort Winnebago Lock in that year. While the Army Corps closed the Upper Fox in 1951, it ended shipping on the Lower Fox in 1959 (Meindl 1991: 40; Vogel 1992: 97; U.S. ACE [Report] 1839-1963 [serial 8005, H. Ooc. 146, 1922: 7, 10, 41-42, 45, 47]; serial 9564, H. Ooc. 212, vol. 3, 1932: 2, 11, 13]; U.S. ACE, Milwaukee District 1951: 5; 1926b [appended letter, 8/17/1931]; Torkelson 1952: 11; Register Democrat 1926 [8/17: 1/2]).

By 1877, a 3' depth had been achieved along the Upper Fox. Although the Fox Waterway navigation system never reached its full project depth of 4' by the 1880s, the Upper Fox saw its greatest commercial use during this period. Until the development of a railroad network during the 1860s, no viable alternative to long-distance transportation existed. Without significant funding by the state or federal government during its early years of construction, there was insufficient capital to support rapid development and completion of the system before the expansion of the railroad network. Hence, the rate of improvement during the 1850s occurred at a slow pace so that the entire system opened to through navigation only during periods of high water in the 1856-58 period. During the 1860s, improvements along the Fox Waterway were limited, particularly during its operation by the Green Bay and Mississippi Canal Company. The slack water system was not completed along the Upper Fox until the late 1870s after its purchase by the federal government. Work along the Upper Fox continued in the 1880s and 1890s to attain the project depth of 4'. Thus, the lack of capital to complete the waterway in a timely manner during its period of greatest potential use and to establish it as a viable system of transportation prior to the completion of the railroad network considerably reduced its level of use after 1880. By the time the waterway gained sufficient improvement to operate, the railroad was well established. In addition, the decision to end improvements along the Wisconsin River in the mid-1880s partly because of the existence of a railroad system reduced its future potential use. By the 1880s, the railroad had a well-developed network, operated all year, moved cargo faster than vessels along a waterway, could drop its rates during the navigation season to maintain its winter business, and could construct spur lines and side tracks to reach their customers (Vogel 1992: 97; U.S. ACE [Report] 1839-1963 [serial 1845, H. Ooc. 1, pt. 2, 1878: 889]).

This study examined the reports and other documents in the records of the Green Bay and Mississippi Canal Company most clearly associated with the construction

of the Fox River Improvement. The collection also includes the papers of the Fox and Wisconsin Improvement Company and the Board of Public Works (Green Bay and Mississippi Canal Company 1848-1909). Data to the year 1872 which deals with tonnages carried along the waterway also probably exist. This information coupled with some of the less specific data contained in the Army Corps reports when compared with data associated with the Illinois and Michigan Canal, considered a relatively successful, contemporary thoroughfare, probably provide sufficient information to understand the role of the Upper Fox Waterway in commerce during its period of peak use. Such a study should examine the years between the 1856 to 1858 period and the early 1880s. However, the data may not be sufficiently specific to pinpoint the level of activity at any one point, for example along the Portage Canal. Certainly worthy of consideration in a manner similar to the Studies on the Illinois and Michigan Canal Corridor by Conzen and Daniel (Conzen and Daniel 1990), this analysis was beyond the scope of this project.

THE CONSTRUCTION OF THE PORTAGE LEVEE

Three segments or reaches, the Portage or Portage City, Lewiston, and Caledonia levees, compose the eighteen mile-long Portage Levee System (figure 15, photograph WI-104-33). This series of discontinuous, sand levees contain thirteen river miles extending above and below Portage. The Caledonia and Lewiston levees prevent overflow of the Wisconsin River into adjacent agricultural lands. The five mile Lewiston Levee protects the north side of the Wisconsin River west of the City of Portage, and the nine and a half mile Caledonia Levee is located along the south side of the Wisconsin River. Their construction restricts the water flow and increases flooding downstream at the canal area in the City of Portage and several miles downstream from the city. The three and a half mile Portage Levee which parallels the northeast side of the Wisconsin River from the Portage Lock south into the Town of Pacific contains the river at these later points.

Because the Portage Levee ties into the west end of the Portage Lock, the lock becomes part of the flood protection structure. The west gates of the lock represent one significant point of weakness in the levee system. For this reason, the state placed a temporary levee across the mouth of the canal in 1992. The Wisconsin Department of Natural Resources maintains the levee under statute s.31.36(4). It is the Portage reach of the system which is being upgraded in 1997 and 1998 under the guidance of the St. Paul District of the Army Corps of Engineers (figure 16). Recent studies of the levee system began in 1971. The final feasibility study and environmental impact statement appeared in 1983 and were updated in 1992 through 1994 (WDNR, Facilities and Lands 1958-97 [file: Portage Levees and Canal, 1993; Lewiston and Caledonia levees, 1997]; U.S. ACE, St. Paul District 1992 [1993-94]: 6; Portage Daily Register 1992 [2/6: 1-2]).

The Portage Canal is aligned along the southeast edge of a low highland on which the main portion of the City of Portage sits. The city separates it from marshes to the west (figure 14). These marshes then lie west of the highland, north of the Wisconsin River, and south of the Fox River. The Big Slough which drains the

marshlands west of the canal into Neenah Creek falls toward the Fox River which is normally about 6' below the Wisconsin River. Since the Fox drains the southeast portion of the state while the Wisconsin River drains the north, the Wisconsin River can reach flood stage while the Fox River remains at low or normal stage. When the Wisconsin runs at extreme flood height, it can reach an elevation 18' to 20' above the Fox River. In the past without the intervention of the levee system, flood waters from the Wisconsin crossed the marshlands through the Big Slough into the Fox River. Such flooding from the Wisconsin River could cover approximately 6,000-7,000 acres of floodplain. Rather than the dams at Lake Winnebago, these waters flooded the valley of the Upper Fox River. The Wisconsin also flooded the farmlands south of the Wisconsin River and rejoined this river through the Baraboo River downstream. And, they cross over into the Fox through the canal and about three miles southeast of Portage in the area of Duck Creek (Smith 1904: 96-97; Mack 1923: 204; WDNR, Facilities and Lands 1958-97 [file: Portage Levee, 1974-91]; Jones et al. 1901: 1).

Observers associated with the fur trade had noted flooding between the Fox and Wisconsin rivers since eighteenth century. Traders utilizing the portage were occasionally able to navigate rather than carry their boats across the portage. Delaying the work of Thomas J. Cram as he inspected the Fox River to make recommendations for its improvement, the flood of 1838 placed 2'-6" of water along the portage. A loaded boat from Galena, Illinois, crossed from the Wisconsin into the Fox during this period. A flood of July 1845 came within an inch of the 1838 flood level. The banks of the canal collapsed during the floods of 1851, and high water again plagued the improvement of the canal in 1852. Significant flooding was recorded in 1866. The floods of 1880 and 1881 inflicted considerable damage in the Town of Lewiston and below the City of Portage. The severity of the 1888 flood stimulated the direct involvement of the federal government as it sought to protect its improvements along the Portage Canal. It was this flood event that involved all three level of government in flood protection along the Wisconsin at and adjacent to Portage (River Times 1851 [7/20: 1-2/1]; Butterfield 1880: 337-38, 436, 449; Kinzie 1948 [1856]: 60; Marryat 1837: 137, 141; Jones 1914: 97-98; Milwaukee Sentinel 1900 [4/29: 10/3]; Smith 1904: 1; Jones et al. 1904: 2).

Responsibility for the construction, maintenance, inspection, and funding of the Portage Levee System has been under a shifting combination of local, state, and federal authority from the 1850s onward. In the mid-nineteenth century, with a few exceptions, the control of flooding and the responsibility for rebuilding following a flood event remained an individual or local responsibility. State governments did not usually become involved in this issue until the last third of the nineteenth century, and the federal government often delayed involvement until the second decade of the twentieth century. Initially, state and federal governments viewed the beneficiary of flood control measures as individuals and local communities. As populations rose and the number of people affected by such events grew, then these levels of government gradually provided increasing assistance. Action at the local level provided only piecemeal protection. This approach lacked the authority, organization, and funding to control the course of a flood along a drainage system of any size.

State funding for flood control began in the 1840s and 1850s in Mississippi and Louisiana. The State of Wisconsin may have made its first contribution to flood protection in its 1870 laws which supported the construction of protective structures in Portage. The 1849 and 1850 Swamp Land Acts granted indirect federal funds for the improvement of lowlands. The federal government donated swampland to the states for drainage and sale. States were to use the resulting funds to protect and drain additional lands. With significant exceptions, the federal government did not provide direct support for flood control until the 1917 legislation. When it did offer assistance before this date, levees became the primary protective structure, and they almost always protected navigation or navigational structures. The exceptions to this policy made under the guise of navigation improvements occurred, for example, along the Mississippi River and through the establishment of the Mississippi River Commission in 1879. The federal government through the Army Corps contributed to the maintenance of the Portage Levee in 1873 to protect the Portage Canal. The 1917 act required considerable financial commitment from local governments which often lacked the resources to provide such cooperation (Armstrong 1976: 247-49; Schneider 1953: 1042-44; Pickels 1925: 4, 6).

As permanent settlement expanded in the City of Portage and adjacent rural areas, periodic flooding of the low-lying areas by the Wisconsin River became more and more intolerable. Citizens near Portage began the installation of flood control structures through private organizations and local governments in the 1850s. Webb and Bronson who platted the Town of Fort Winnebago in 1849 constructed a levee south of the canal to prevent flooding and raise land values. In 1854, the Fort Winnebago and Duck Creek Plank Road Company built short levees between the plank Road and the north bank of the Wisconsin River to protect their plank road which ran from the canal south along the river. The company had received authority for construction from the state legislature under Chapter 159 of the 1854 laws (Fort Winnebago and Duck Creek Plank Road Company 1851-74; River Times 1850 [11/4: 2/2]; Butterfield 1880: 598; Smith 1904: 98; Wisconsin Division of Resource Development, Engineering Service ca. 1967).

Farmers in the Town of Lewiston constructed a series of small dikes equivalent to four miles in length between 1861 and 1880. The town received some funding for these levee projects through the sale of state swampland under the 1850 federal Swamp Land Act. The method of organization used to coordinate this project is unclear. Since the State of Wisconsin failed to establish drainage districts by this period, organization of the affected land owners may have been through a temporary commission established by the state and funded through the town. The drainage commissioners appear to have been appointed by the legislature on a temporary basis to perform a specific task. Wisconsin did not formalize the organization of drainage districts until 1919. And, the 1919 legislation addressed land drainage rather than the construction of protective levees to prevent flooding (Smith 1904: 98-99; Mack 1923: 204; Jones et al. 1901: 2; Moreel 1972 [1956]: 31-32; Pickels 1925: 419-20, 423).

In March 1870, Chapter ninety-eight of the Laws of Wisconsin (Wisconsin, State of [Laws] 1848- [1870: 155-56]) did establish a temporary commission including C.R. Gallett, George Wall, and S.S. Brannan to oversee the protection of Portage

and adjacent areas from further encroachment by the Wisconsin River. The legislature appropriated \$5,000 from the general fund for the project. Their report of 1873 indicated that the river had shifted north onto the center of Wisconsin Street in at least one location in Ward I (figure 14). To protect the location from spring flooding, the commission directed the construction of temporary wing dams and docking. Two parallel rows of oak pilings tied with iron bolts and divided by sheet piling and earth composed the 32' long dock. The commission had this work completed in 1870, and minor repairs were conducted in 1871. In 1873, the Milwaukee District of the Army Corps which was then constructing wing dams along the Wisconsin River south of Wisconsin Street took charge of the improvement. The Army Corps sloped the shore near the dam and protected the bank with gravel, brush, and stone. It is probable that these structures were added to the site of an existing levee, perhaps the ones erected in the early 1850s. Wisconsin Street appears to have followed the course of an old levee. An 1881 map produced under the direction of D.C. Houston of the Milwaukee District indicated only shore protection running along the river from the south side of the canal to a point between Michigan Street and Wauona Trail (U.S. ACE, Milwaukee District 1881). However, an 1889 map showing the proposed position of a new levee eventually built in the early 1890s indicated the existence of an earlier levee structure which followed Wisconsin Street to Wyocena Road in the Town of Pacific (Hoffman 1889).

In Chapter 213 of the 1873 laws (Wisconsin, State of [Laws] 1848- [1873: 464-65]), the state legislature also gave municipalities and towns in the vicinity of Portage the authority to construct and maintain a levee along the south bank of the river. It was found that the Portage Levee directed waters toward this side of the river. The levee could run from the vicinity of Portage west through the Town of Caledonia and as far west as Fairfield. The laws further authorized the towns of Caledonia and Fairfield and City of Portage to levee a tax for their construction. Those land owners in the Town of Caledonia directly benefiting from the improvement could pay an additional tax equal to one-third of the cost of the levee's construction. The law's intent was to reclaim lands subjected to overflow and protect highways from inundation. The Caledonia Levee was then erected sometime after this date and prior to 1881 (Wisconsin Governor 1840-1914 [folder 3, box 10, 1871-79, 1873 report]; U.S. ACE, Milwaukee District 1881; Wisconsin Division of Resource Development, Engineering Service ca. 1967).

These initial levees erected under the auspices of the local, state, and federal government proved ineffective during the flood of June 1880 and October 1881. During this event, the Lewiston Levee broken at several locations. Inflicting considerable damage, waters from the Wisconsin River flooded the valleys of Neenah Creek and Fox River for a distance of about 100 miles. Residents along the Fox sued the federal government for loss of property caused by flooding from the Menasha Dam along Lake Winnebago. Although they recovered substantial sums, the flood water in fact originated from the Wisconsin River (Smith 1904: 98-99; Mack 1923: 204; Jones et al. 1901: 2).

To prevent the reoccurrence of the 1880 and 1881 flooding, the state under Chapter 138 of the laws of 1882 provided \$6,000 from the Swamp Land funds to reconstruct the levees in the town of Lewiston. The Chicago, Milwaukee, and St.

Paul Railroad may have contributed to this funding. The project provided protection for its railroad embankment. When funding proved to be insufficient, Congress appropriated an additional \$3,000 in the river and harbor bill for that year to protect the government's navigation improvements. Although the \$9,000 total remained inadequate to fully fund the necessary improvements, the Town of Lewiston rebuilt a portion of the levee system. Its levee commissioners, A.J. Turner, Albert Schmarf, and C.R. Gallett, advertised for bids to complete the work in The Town of Lewiston in June 1882. The structure reached completion in November 1882. This early structure measured approximately 5' above the high water mark of 1881 and had an 8' width across its crest. The outer slope possessed a ratio of two-to-one and the inner or landward slope of one-to-one and a half-to-one. The town made additions to the system in 1883 and 1886 (WDNR, So. District 1971-81 [file: Portage Levee]; Jones et al. 1901: 2-3; Smith 1904: 100; U.S. ACE [Report] 1839-1963 [serial 4787, H. Doc. 2, vol. 7, pt. 3, 1904: 2846]; Wisconsin Governor 1840-1914 [folder 6, box 10, 1882-97, 1882 papers relating to Lewiston Levee]; U.S. [Statutes] 1846- [Chapter 375: 1883: 191, 203]).

The improved Lewiston Levee directed the flood waters of the Wisconsin River which had previously flowed down Neenah Creek to the Fox River over the lowlands south of the Wisconsin River into the Town of Caledonia, the Saraboo River, and the adjacent floodplain. The flood waters rejoined the Wisconsin River about five miles south of Portage. To protect these lands, the City of Portage and Town of Caledonia constructed levees extending ten miles along the south or right bank of the Wisconsin River. They were completed between 1883 and 1885. In 1884 and 1885, the Town of Fairfield also constructed a levee along the south side of the river west of the Caledonia Levee. The legislature authorized their construction under Chapter 322 of the laws of 1883. It provided funds from the sale of swampland to support the construction. All monies derived from the sale of swampland in the two counties since the passage of the 1850 act were specifically allocated to these levees (Wisconsin, State of [Laws] 1848- [1883 (vol. 1): 284]).

The levees placed along both banks of the river raised the height of the flood waters south of the canal and south of the City of Portage. This flooding endangered property of the federal government at the canal as well as the property of private citizens. In both the 1886 (U.S. [Statutes] 1846- [Chapter 929, 1887: 310, 325]; see also Wisconsin, State of [Laws] 1848- [Chapter 134, 1889: 411]) and 1888 (U.S. [Statutes] 1846- [Chapter 860, 1889: 400, 418]) river and harbor bills, Congress appropriated \$6,000 to construct a levee along the left or north and east banks of the river in the City of Portage and the Town of Pacific. The federal government withheld these monies until 1889. Prompted by a severe flood at Portage in 1888, the government then provided the \$12,000 for their intended purpose. The Army Corps justified this expenditure on the Portage or Government Levee primarily if not solely on the basis that it protected the improvements along the canal, a navigation improvement. The State of Wisconsin permitted the United States to construct and maintain the levee. The Wisconsin attorney general's office ruled favorably on the acquisition of title to the property by condemnation proceedings under the United States in 1889 and 1890. The state enabled adjacent towns and City of Portage to acquire title to the necessary lands after the condemnation proceedings.

Reconstruction of the Portage Levee began in the fall of 1889 and reached completion in January 1890. The Milwaukee District of the Army Corps employed contractor S.A. Harrison who was then repairing the Fort Winnebago Lock. He reconstructed the 14,658' long Portage or Government Levee from the south side of the Portage Canal to high land two and a half miles to the south at Wyocena Road in the Town of Pacific. In many places, it followed the path of the earlier levee. The structure measured 12.5' high above the zero mark of the gauge at the Portage Lock. The earthen structure was protected with brush and stone riprap.

The Portage Levee and associated structures received further improvement between 1891 and 1893. The abandoned wing dams erected across from the Portage Levee for navigation improvements along the Wisconsin River directed the water toward the levee. The channel was then undermining the structure, potentially causing the levee to collapse into the river. In 1891, the Army Corps added one stone wing dam to protect the levee along the east bank of the Wisconsin in Ward I. This structure extended 97' from the foot of Superior Street into the river and then paralleled the levee for 575'. It possessed a crest of 7', a base of approximately 27', and a height of 5' above the zero mark of the Portage Lock gauge. The lowering of the navigational wing dams along the opposite bank increased the width of the channel adjacent to the levee by 120'.

In 1891, the improvements south of the canal required the extension of the levee along the opposite bank in the Town of Caledonia. The state specifically designated monies from county and town drainage funds for the project (Wisconsin, State of [Laws] 1848- [Chapter 121, 1891: 144-45]). The City of Portage also constructed the Barden Levee within its jurisdiction on the south side of the river at the southeast end of the Caledonia Levee. The Army Corps continued to work on the Portage Levee in 1893. It raised a weakened, 400' long section 1' and widened it 6' to created a 12' top width. It conducted minor repairs at additional locations in 1893 and probably continued to do so through 1900. The additions to the levee system in the 1890s brought the total length of the levee to seventeen miles (Jones et al. 1901: 3-4; U.S. ACE, Oshkosh Office 1896-99; WONR, So. District 1971-81 [File: Portage Levee]; Mack 1923: 204-05; U.S. ACE [Report] 1839-1963 [serial 2832, H. Doc. 1, pt. 2, vol. 2, pt. 3, 1890: 2365-66, 2376-77; serial 2925, H. Doc. 1, pt. 2, vol. 2, pt. 4, 1892: 2573, 2576; serial 3202, H. Doc. 1, pt. 2, vol. 2, pt. 4, 1893: 2768-69; serial 4787, H. Doc. 2, vol. 7, pt. 2, 1904: 2846-47]; Bambery 1866-1960 [folder 1, box 4, 1899: 168]; Hoffman 1889).

During the flood of April 24, 1900, the Portage City Levee broke in two places one and a half miles south of the canal and south of the toll gate along the plank road in the Town of Pacific. At this location, the course of the river began to shift from east to south. The 30' width of the crevasse in the levee which later widened to 125' occurred at locations weakened by cattle crossings. The opening permitted water to flow toward the Fox River through the canal, and waters covered a broad area in the surrounding lowlands. The flood waters filled the canal with sand and mud, washed-out the railroad tracks, collapsed one wall of the Fort Winnebago Lock, and damaged the canal revetments adjacent to the waste weir. This break delayed the operation of the Chicago, Milwaukee and St. Paul and the Madison and Portage branch and resulted in considerable damage to

residences south of the canal. The flood occurring in October of that year again threatened the Portage Levee and breached the Fairfield and Barden levees. Citizens from Portage and about 100 individuals employed by the railroad prevented a break in the Caledonia Levee along the opposite bank of the river. The federal government hired J.O. Splaine to repair the levee. Work began on July 25, 1900. He filled the breaks primarily with the sand available from the river bed. Work along this segment created a top width of 6' and a slope of a one and a half-to-one ratio and placed riprap on the river side of the levee. The contractor completed the work in September 13, 1900 (Milwaukee Sentinel 1900 [4/29: 10/1-3]; Milwaukee Journal 1900 [4/24: 1/4]; U.S. ACE [Report] 1839-1963 [serial 4093, Doc. 2, pt. 5, 1900: 3729-30; serial 4282, H. Doc. 2, pt. 4, 1901: 2965]; Bamberg 1866-1960 [folder 1, box 3, 5/4/1900: 60-64; 8/4/1900: 119]).

In 1904, Leonard Smith examined the Portage Levee in the Wisconsin Engineer, analyzing it through data gathered by the Army Corps while improving the Mississippi River levees. He concluded that the structure failed because the sand which composed the levee permitted the structure to become quickly saturated; because its height did not contain the flood and its width did not create a sufficiently stable structure and permitted saturation; because the Wisconsin River was gradually shifting toward the levee and eroding its base after the construction of the levee along the opposite bank; because the entire system stood too close to the bank of the river and raised the river's height by decreasing its cross-section and eliminating the natural floodplain; and because the levee rather than paralleling the river made several sharp turns at the point where the river turns from east to south. The report also observed that the removal of timber in northern Wisconsin had increased the run-off (Smith 1904: 99-107).

A 1901 memorial to Congress from the mayor of the City of Portage, J.E. Jones, and the chairmen of the adjacent towns requested financial assistance to enlarge and strengthen the Portage Levee (Jones et al. 1901: 6-7). The memorial concluded that the levee structure protected a large area which covered not only the city and adjacent towns along the Wisconsin River but also the Upper Fox Valley. The 1904 report of the Army Corps explained that after the government had abandoned the improvement of the Wisconsin River, the Portage Canal lost its significance to the navigation interests of the United States. With the exception of pleasure craft, the Upper Fox carried little traffic at that time. The only United States property protected by the Portage or Government Levee was the canal and two locks. This report recommended that the government abandoned the levee and deed the structure to the city so it could perform the necessary repairs. It also recommended the suspension of channel improvement above Montello. Hence, by 1904, the federal government funded flood control measures only when they protected navigation improvements which held importance to commercial interests (U.S. ACE [Report] 1839-1963 [serial 4787, H. Doc. 2, vol. 7, pt. 2, 1904: 2847-48]).

Under Chapter 282 of its laws of 1900 (Wisconsin, State of [Laws] 1848- [1901: 381-82]), the state appropriated \$20,000 from the general fund for the construction and strengthening of the Portage Levee. The act also created the three-member Portage Levee Commission to administer the project. Appointed by

the governor, its members were to audit and certify project bills and oversee construction, repair, and maintenance of the Portage Levee System. Under this initial law, the state was to incur no further obligations for the Portage Levee. The towns and the City of Portage gained the responsibility for the purchase of necessary right-of-way and for long-term maintenance.

The commission presented a statement to the state for payment of the land survey prior to construction. This act initiated a review of the state's involvement in the project. In 1902, the Wisconsin supreme court found that the 1900 appropriation violated the state constitution under Section 10 of Article VIII because it supported an internal improvement. Section 10 represented a reaction to the unchecked state spending associated with the financing of internal improvements during the 1830s. This spending had caused bankruptcy in adjacent states prior to Wisconsin's statehood. In the decision, entitled The State ex. rel. Jones versus Froelich (115 Wis. 32), the court confirmed the state's inability to appropriate funds to or contract a debt for internal improvements or participate in the construction of such works. Despite the levee's function to prevent peril to human life, the court concluded that sufficient financial benefit accrued to private parties from such structures that they fell under the scope of this definition as did improvements for navigation, creation of waterpower, land reclamation, or any other function which did not involve the execution of government function. In sum, the constitution forbade the state to expend monies for purposes of flood control or restore properties damaged by flooding.

Although the constitution prohibited the state from such expenditures, it did not bar local governmental units, that is counties, towns, and municipalities, from contracting such a debt as part of their police powers. In a sense, the state, restrained from such action, delegated its authority to other units of government for this purpose (WDNR, So. District 1971-81 [File: Portage Levee]). And, the constitution permitted the state to become involved in works of internal improvement if it received funding for it through the sale of property granted to it by the federal government for the improvement without incurring a state debt. This exclusion had permitted the state construction of the Fox Waterway. The legislature chose to provide appropriations for the levee from the sale of swampland granted to the state by the federal government under the Swamp Land Act of 1850. The funds were to support the construction of necessary levees. Thus, rather than spending years in seeking the passage of a constitutional amendment concerning the construction of levees such as was the case for government spending for highways, forests, and port facilities, the legislature sought other ways to accomplish the same goal. Also, such circumvention probably reflects the court's concern for maintenance of the state's solvency as its role began to expand (Conover 1903: 32-43; Mermin 1963: 72-73; 1968: 156-59; Hurst 1964: 574-79).

Chapter 419 of the 1903 law granted up to \$20,000 to the Portage Levee Commission to repair in a more permanent manner the breaches of the Portage Levee and to strengthen the structure (Wisconsin, State of [Laws] 1848- [1903: 682-83]). If the drainage fund provided an insufficient amount, then monies were allocated to this fund from one of the state trust funds. The height of the then seventeenth

and a half miles of levees was to reach 2' above the high water of the 1900 flood. The work which began in 1903 probably continued until 1904 or 1905. By 1905, the commission had also directed the construction of a new embankment behind the Government Levee near the Portage Lock (U.S. ACE [Report] 1839-1963 [serial 4947, H. Doc. 2, vol. 6, 1906: 2049]; Tennant 1913).

Appropriations for the levee under later acts continued the commission created in 1901. Although swampland did not exist after the 1920s, the state maintained the drainage fund by appropriating monies to it from the general fund until 1961. Until 1916, the Army Corps provided some of the expertise and work force to maintain the levee. It appears that at least one member of the commission possessed the expertise to supervise the inspection of the levee. Maintenance, rebuilding, and extension were let by the commission to local contractors. The commission became a permanent part of the state government when placed in the Engineering Department under Chapter 751 of the Laws of 1913. In this law, the state more clearly defined the duties of the state commission, to construct, strengthen, and maintain the Portage Levee so that the structure provided protection against the overflow of the Wisconsin River. The law also gave the commissioners the authority to condemn lands to provide a right-of-way for these structures and to give access to the necessary materials utilized in their construction. The commission's role was gradually clarified through time and became well established during the early 1920s when H.V. Tennant of Portage served as a member of the commission (WDNR, So. District 1971-81 [file: Portage Levee]; WDNR, Facilities and Lands 1958-97 [file: 1974-91, Portage Levee (opinion file)]).

Although the Army Corps no longer funded significant improvements along the levee, it continued to inspect the structure and complete limited repairs until 1916. The roles of the commission and the agency appear to have lacked complete coordination. In 1909, the Army Corps surveyed the position of the river's edge in relation to the levee between the canal and the tollgate to measure the amount of encroachment on the levee since 1886. It also protected 3400' of this section of the levee with riprap taken from the navigation wing dam across the river. In 1908, the Portage Levee Commission had placed a wing dam of pilings, brush, and stone to protect a separate section of the levee. The Milwaukee District of the Army Corps subsequently raised its height four feet. The Army Corps also filled in a break in the river bank with a 5' high wall of stone. At this time, the council of the City of Portage rejected the Army Corps' offer to deed the levee to the city.

After the flood of 1911 threatened the levees along Ward I, Congress directed the Army Corps through the 1912 river and harbor act to determine the repairs and extensions necessary to protect the navigation structures at Portage. The Army Corps was to enter into cooperative projects with state and local governments when possible. The state provided the identified funding. In 1912, it initially allocated \$20,000 for work on the levee. Under Chapter 166 of its laws, it designated an additional \$25,000 to complete construction of the levee system under the supervision of the commission. Between 1912 and 1914, the commission utilized these funds to increase the height of the Portage Levee System 3' above the high water mark of the 1911 flood. It also proportionately widened the

levees and added shore protection, wing dams, and bulkheads.

Again, in 1913, the Secretary of War recommended deeding the Portage Levee to the city and indicated that the state or similar entity assume the responsibility for its maintenance. While Chapter 751 of the 1913 Laws of Wisconsin reaffirmed the mandate of the Portage Levee Commission for the levee, further initiatives were not pursued to completely shift the responsibility for the levee to the state. The federal government with occasional assistance from the Levee Commission continued to maintain the levee system until 1916. In that year, Congress directed the Secretary of War to quitclaim to the State of Wisconsin or to the City of Portage title to the Portage Levee including its right-of-way. The State of Wisconsin then made appropriations to continue its maintenance. By 1923, this approximately eighteen mile-long levee system had reached a height of 7', a top width of 6', and a base width of 48'. The Portage Levee included 3000' of timber bulkheads; fourteen, mat and stone wing dams intended to direct the flow of water away from the levee; and shore protection including riprap and revetments. By this period, the state then provided an annual appropriation of \$5,000 to maintain the levee (Mack 1923: 206; Bamberg 1866-1960 [folder 1, box 3, 8/4/09: 431; 8/26: 13-14, 24; Wisconsin, State of [Laws] 1848- [1913: 162]; U.S. [Statutes] 1846- [Chapter 253, 1912: 201, 229; Chapter 260, 1916: 391, 401]; U.S. ACE [Report] 1839-1963 [1910 [pt. 2]: 2142]; WONR, Facilities and Lands 1958-97 [file: Portage Levee, 1974-91, memo, 5/18/79]; Jones 1914: 99; Tennant 1913).

Between the 1870s and the 1930s, the problem of the inundation of low-lying lands along the course of the Upper Fox between Lake Winnebago and the Wisconsin River was periodically broached. Flooding of 3' to 5' across areas as wide as two to five miles occurred annually along this section of the river. Beginning shortly above 1876 shortly after the United States acquired responsibility for the improvement in 1872, riparian land owners filed claims with the United States to gain compensation for the flooding of their lands (U.S. ACE [Report] 1839-1963 [serial 1744, H. Doc. 1, pt. 2, vol. 2, pt. 2, 1877: 397]). It was presumed that the level of Lake Winnebago necessary to provide navigation for the lower river caused the flooding. The United States paid compensation for flowage damages affecting 9,000 acres. However, it was later found that the improvements facilitated the drainage of these lowlands, thus affecting water levels along the upper river. And, the Army Corps found that waters from the Wisconsin River periodically flooded the upper valley.

As the Army Corps considered the abandonment of navigation improvements above the Wolf River in the early 1920s, it addressed such issues as the amount of navigation, flooding, land reclamation, and the production of hydroelectric power on the Upper Fox. It projected the possible reclamation of 76,260 acres of relatively fertile land by the construction of levees and pumping of water from the lowlands. The 1922 report of the Milwaukee District observed that the Wisconsin drainage law provided the needed authority to execute such a plan by the reformation of existing drainage districts into larger units to oversee the planning, construction, oversight, and maintenance of the necessary levees. The report indicated the Army Corps' cooperation for such a project included either the removal of or the raising of the lock walls and canal embankments and adjusting the discharges on the Lower Fox. The report also addressed the

potential for increasing the production of waterpower and improving navigation by lowering the height of the Menasha Dam and deepening the channel along the Lower Fox. Completion of the outlined program required the organizational and financial cooperation of the affected interests (U.S. ACE [Report] 1839-1963 [serial 8005, H. Doc. 146, 1922: 11-12, 53-62]). While the proposed programs were never undertaken, the Army Corps began to consider the implications of its projects in the areas of flooding and land reclamation and the production of hydroelectric power as well as navigation. Twenty years after withholding funds for the improvement of the Portage Levee, the need to justify these auxiliary issues as effects on navigation improvements seemed less essential.

Between 1921 and 1961, H.V. Tennant served as the secretary and engineer for the Portage Levee Commission. He worked from his office at General Engineering in Portage. During this period, the discontinuous sand levees were periodically raised and strengthened, but not significantly extended. For example, after a flood in 1922, Chapter 394 of the Laws of 1922 placed from the general fund into the drainage fund \$50,000 to strengthen the levee system near Portage. A series of short wing dams were built to protect the north bank between Brookes and Erie street in Ward I (Wisconsin, State of [Laws] 1848- [1923: 682-83]; Tennant 1923). In at least 1934, Works Progress Administration (WPA) funds supported work along the levee system in the Town of Caledonia. During the 1921 to 1961 period, the flood of September 1938 caused the only breach. A school bus filled the 20' gap which occurred in the Portage Levee. The flood waters also overtopped the levees in other places. A portion of the levee system was then raised 2' above the 1938 flood level. It may have been at this time that the two one room, ashlar stone masonry levee patrol or gauging stations were placed on the opposite banks of the Wisconsin River at a point just south of the Portage Lock. Tennant's 1923 map indicates a gauging station approximately near the Portage Lock, but the second building was not indicated. Additionally, their rough stone construction was very similar to the forms produced by WPA projects (WDNR, So. District 1971-81 [File: Portage Levee]; General Engineering Co. ca. 1967; U.S. ACE, St. Paul District 1983: 13, 32, 37; Tennant 1923).

As the federal government's role in flood control became clarified in the second and third decades of the twentieth century, Congress provided for several flood control studies along the Wisconsin River. Authorized by the River and Harbor Act of 1927 and the Flood Control Act of 1928, the St. Paul District completed a 1929 study which resulted in the 1930 report. The Army Corps had expanded the boundaries of the St. Paul District to include the Wisconsin River in 1919. The report addressed issues of flood control, navigation, the production of hydroelectric power, and irrigation along the Wisconsin River and its tributaries. The study found levees reaching 6' in height or a flood stage of 20' extending along both banks from a location twelve miles above Portage to one to three miles below the city. Its examination included the effect of the twenty-one storage reservoirs maintained by the Wisconsin Valley Improvement Company at the headwaters and tributaries of the Wisconsin River. These reservoirs did store flows which were released as required for the production of hydroelectric power and thus to a limited degree effectively reduced the spring flood stages along the lower river. However, the reservoirs could be at their capacity during the summer months at the occurrence of a major storm. Thus, the

intent of the operation was not flood control. Nevertheless, the 1930 report concluded that no serious flooding occurred along the Wisconsin River, and flood control measures including the Portage Levee were adequate (U.S. ACE, St. Paul District 1929; U.S. ACE [Report] 1839-1963 [serial 9254, H. Doc. 259, 1930: 1-2, 5, 44]).

Under the Flood Control Act of 1931, Congress authorized a preliminary examination of the Fox River. The district engineer at Milwaukee requested a flood control plan to resolve continuing conflicts between the production of hydroelectric power and navigation on the Lower Fox and flooding and reclamation of riparian lands on the Upper Fox. Although the flood discharge from the Upper Fox was comparatively limited, a considerable amount of overflow occurred along the upper river basin. The report recommended flood control by construction of a series of reservoirs and levees. However, because the federal interest in the project, presumably the navigation interests, were limited, the Army Corps remained unable to justify extensive federal expenditures for flood control. The district did acknowledge the potential need to modify the navigation structures to assist local interests in their flood control measures. And, the district recommended the completion of a survey to determine the feasibility of this approach to flood control and its effects on the existing structures. This more intensive survey was not completed in the 1930s. While the Army Corps lent assistance and funding in the planning in flood control projects and supported the navigation project along the Upper Fox, the report made it clear that organization and funding of flood control measures remained at the local and state level (U.S. ACE [Report] 1839-1963 [serial 9564, H. Doc. 212, vol 3, 1932: 1-6, 19, 23-24]).

Requested by the Senate Committee on Commerce in 1941, a 1944 preliminary report by the St. Paul District reexamined flooding along the Wisconsin River and determined that the Portage Levee provided adequate protection. The report did recommend a survey to develop a flood control program for the Wisconsin River Basin. However, as World War II absorbed increasing government funding and attention, this survey never occurred. Rather, a brief letter report of January 28, 1955, indicated that further action was unnecessary. Under its own initiative in ordinance No. 681, the City of Portage did legally alter the definition of its shoreline along the Wisconsin River which in some places had moved 200' to 300' toward Wisconsin Street. Additionally, in 1946, Congress authorized a preliminary examination and survey of the Fox River and its tributaries for the purposes of flood control. The Milwaukee District submitted a preliminary report on flooding along the Upper Fox in 1948, and a survey was authorized. Although some basic data were gathered, this survey was placed in a deferred status by 1951 (U.S. ACE, Milwaukee District 1951: 5; Wisconsin Public Service Commission 1954-65 [No. 4579, 1956]).

In 1970, the Wisconsin Department of Natural Resources requested the examination of the Wisconsin River Basin near Portage by the St. Paul District of the Army Corps. Section 205 of the federal flood control act of 1948 provided the agency the authority to conduct a reconnaissance level study of the levee system in 1971. The report concluded that the Portage Levee System failed to meet the Army Corps' design standards. It recommended the strengthening, raising, and

extension of the Portage and Lewiston levees as the most feasible flood control measure in this area. A 1972 sequel report provided data on past floods and projected the likely extent of future floods. In 1971 during the period of these studies, the St. Paul District added a 1000' long flood emergency levee at the south end of the Portage Levee to tie it into STH 51. After a 1973 flood rose to the top portion of the levee, the St. Paul District erected a second emergency levee in Ward VIII of Portage which was later removed. These studies initiated a series of planning documents dating to 1977, 1983, 1992, and 1993-94 from which the current levee improvement project emerged (figure 16). The 1977 study constituted the first comprehensive examination of the flood control alternatives on the Wisconsin River in the area adjacent to Portage (WDNR, So. District 1971-81 [File: Portage Levee]; General Engineering Co. ca. 1967; U.S. ACE, St. Paul District 1977: 5-6; 1983: 5; 1992 [1993-94]; U.S. ACE, St. Paul District 1977).

At the state level, regular appropriations for the Portage Levee System were made through the Portage Levee Commission until 1961 when it was abolished in Section 108 of Chapter 191 of the Laws of 1961. Created under Section 69.31.36(1) of the same act, the Water Regulatory Board gained the responsibility for supervising activities related to the levee. Still based at Portage with a foreman and laborers at Babcock and Portage, H.V. Tennant also served as the Secretary and Engineer of this board. The law defined its primary task as the supervision of the operation, repair, and maintenance of dams and dikes erected in drainage district. The law specifically gave the board jurisdiction over the Portage Levee. When the board was eliminated in 1965-66, this responsibility was shifted to the Wisconsin Public Service Commission. This state agency had jurisdiction over the level and flow of navigable waters which included the Fox River and the Portage Canal under Section 31 of the Wisconsin Statutes. While this commission had authority over the water in the stream, the riparian owner possessed land ownership rights to the bed of the stream.

The Wisconsin Department of Natural Resources gained responsibility for management of the levee when the agency was created in 1967. Section 31.36(4) of the Wisconsin statutes essentially transferred the duties of the commission to the Department of Natural Resources. The statute directed the department to construct, strengthen, and maintain the Portage Levee to ensure that the flood protection structures prevented overflow of the Wisconsin River in that vicinity. This authority failed to transfer to the department the commission's power to condemn land, often necessary to provide right-of-way and materials for construction of the levee. Two sections of the department administrated the levee. The Water Regulation Section based in Madison gained responsibility for the oversight of the operation and maintenance of the levee, particularly its inspection, and the Horicon supervisor of the Southern District provided personnel for the routine maintenance programs. Routine maintenance primarily included levee inspection to monitor erosion and breaks in the levee, grass and brush cutting, vermin control to eliminate borrowing, and the filling of holes.

The St. Paul District of the Army Corps of Engineers and the Wisconsin Department of Natural Resources completed their studies of the Portage Levee system in 1994. Funded by both agencies, the rebuilding of the levee began in 1997. After completion of the project, the City of Portage gains responsibility for

maintenance of the City of Portage Levee while the Wisconsin Department of Natural Resources continues its current authority for the Lewiston and Caledonia levees (Mermin 1968: 156-59; Jones 1914 [1]: 94-97; U.S. ACE, St. Paul District 1981: 18-19; Butterfield 1880: 598; WDNR, So. District 1971-81 [File: Portage Levee]; WDNR, Facilities and Lands 1958-97 [file: 1970-91, memo dated 2/13/70; file: 1974-91, memo dated 8/23/65]; 1951-87 [files: Portage Levee, 1972, 1989, and 1995-97]; General Engineering Co. 1967; Oakey 1957: 28; Wisconsin, State of [Laws] 1848- [1961: 137, 158]).

Thus, the involvement of local, state, and federal agencies at Portage followed a relatively common pattern. Local government units and private organizations began flood protection measures early in the history of Portage, in the 1850s. Some of these early projects benefitted from federal funds available through the Swamp Land Act of 1850. State laws assisted flood control measures by offering a method of land organization through the levee commissioner and periodic funding for flood control structures. The Milwaukee District of the Army Corps of Engineers became involved in these projects in 1873 after it gained the responsibility for the Fox River Improvements in 1872. Between the 1870s and 1890s, it funded some of the levee repair and construction projects which directly affected its navigation improvements at Portage. It rebuilt the Portage Levee in the 1890s which then also became known as the Government Levee. During this period, both the state and local governments also funded and oversaw levee projects along the Wisconsin River.

After the federal government abandoned the improvement of the Wisconsin River and navigation along the Upper Fox and Portage Canal significantly declined, the Army Corps first ceased to expend funding for significant construction along the Portage Levee and then in 1916 deeded the right-of-way to the City of Portage. After the flood of 1900, the constitutional ban on expending monies on internal improvements prevented the state from appropriating funds to improve the levee. In 1903, the legislature circumvented this legality by use of the drainage funds. The Portage Levee Commission formed in 1901 oversaw the improvement of the Portage Levee. The commission and after 1961 other state agencies remained the primary government office to inspect and maintain the structures of the Portage Levee System. Although the St. Paul and the Milwaukee districts of the Army Corps considered flooding and other issues along the Wisconsin and Fox rivers beginning in the early 1920s, their reports found that federal expenditures for flood control particularly in relation to its navigation structures were unnecessary. The Army Corps did not become actively involved in planning and funding the flood control project at Portage until 1970 in response to the request of the Wisconsin Department of Natural Resources.

STRUCTURAL INFORMATION



Introduction

The Portage Canal includes the canal structure originally finished with wood revetments and a waste weir west of the Fort Winnebago Lock. The canal connects

the Portage Lock at its west end and the remains of the Fort Winnebago Lock at its east end.

The Portage Canal gains significance as a structure as part of the Fox Waterway which was built over a long period of time. The initial construction of the project lasted over a quarter of a century between 1849 and the 1870s but components of the system were gradually replaced so that one lock was rebuilt as late as the 1970s. Thus, the entire system represents a number of different approaches to lock construction.

Composite, stone, and concrete locks with hand-operated gate mechanisms remain along the waterway. The Portage Lock is the first of five concrete locks with steel gate closure on the waterway and the only concrete lock on the Upper Fox. Composite locks of rubble stone and timber cribbing once composed the most common manner of lock construction along the Fox Waterway. Before most of the structure was dismantled, the Fort Winnebago Lock originally represented this type of construction. On the Lower Fox, the composite lock is currently only represented by the fifth lock at Kaukauna. Besides the Fort Winnebago Lock, portions of one stone and wood composite lock currently occurs along the Upper Fox. The Montello Lock, most recently replaced in 1900-01, was altered to a water control structure in 1959 (Richards 1995: 10; 1985 [WI-87]: 3-4, 19; Meindl 1991: 24, 30-31). This lock was constructed in the 1850s and, although extensively repaired, it was never replaced.

The Portage Canal differs in function and construction from the other short canal along the waterway. The Portage Canal connects the Fox and Wisconsin rivers at the summit level of the waterway. Its banks were secured with timber revetments. The other short canals along the system generally provided access around the navigation dams. Their banks generally remained unfinished. In this sense, the Portage Canal represents a unique portion of the Fox River Improvement (Meindl 1991: 18).

Since the completion of its initial construction between 1849 and 1851, both locks and the canal were rebuilt and extensively renovated numerous times as were many of the other structures along the waterway (see Table 1). Portions of the canal underwent five major rebuilding projects. The Portage Lock was replaced two times and renovated three additional times. It was most recently rebuilt between 1926 and 1928. The Fort Winnebago Lock was rebuilt twice, most recently in 1890. After that date, it was extensively repaired in 1900-01, renovated in 1936, and dismantled to the water line in 1958-59. The descriptive data below primarily address its current appearance with interpretation in the case of the Portage Canal and the Fort Winnebago Lock as to what the remains represent. Recent alterations, those dating after the closing of the waterway to commercial navigation in 1951, are also noted. These alterations primarily include additions of bridges, footbridges, fencing, and a temporary levee; replacement of revetments; and silting-in of the waterway. Functionally, it currently represents an abandoned navigational structure.

The Canal

Here, the term canal denotes that portion of the Portage Canal between the two lock structures (photograph WI-104-33). West from the Fort Winnebago Lock, the canal transverses a low, marshy rural landscape with buildings scattered away from its banks until it reaches Center Street and the Soo Line Railroad bridge. Trees and tall grasses generally border the canal along this distance. Between the railroad bridge and Adams Street, primarily residential, but also a limited number of industrial buildings along the southeast side, stand back away from its banks. Cut or long grasses and scattered trees are located along its banks in this area. The portion of the canal between Adams and Lock streets represents the business district to the north and a small industrial area to the southeast. Buildings stand close to or abut the canal in many places, especially between Wisconsin and Adams streets. Between the Portage Lock and MacFarlane Street, a residential area borders the canal to the northwest. A park-like area lies along the lock to the southeast. In this area, mowed grasses line the canal's edge.

The canal reaches a total length of about 10,894' or 2.06 miles. The banks of the structure are approximately 75' apart. The depth of the canal varies with the amount of rainfall. During much of the year, the canal is extremely shallow. The limiting depth along the canal reached 1.8' by 1950. At the west end, the section between the Portage Lock and Adams Street has a gravelly bottom. In many areas, silt and muck varying in depth from 1' to 1.8' in 1991 occur between Adams Street and the Fort Winnebago Lock. And, grasses and other low vegetation are visible along much of its bottom between Adams Street and the Soo Line Railroad Bridge. Vegetation along the bottom diminishes considerably between the railroad bridge and the Fort Winnebago Locks (General Engineering, Inc. 1991). Along the section northeast of the STH 33 bridge, the banks are visibly built-up with debris dredged from the bottom of the canal. This method of disposal was recorded by Captain G.J. Lydecker who served under Major D.C. Houston of the Milwaukee District in 1876 (U.S. ACE [Report] 1839-1963 [serial 1722, H. Doc. 1, pt. 2, vol. 2, pt. 2, 1877: 413]).

The Milwaukee District of the Army Corps contracted with Conro, Starke & Co. of Milwaukee to complete the replacement revetments along the canal between November 1874 and July 1876. The canal banks were reinforced where deteriorated with 7' high revetment walls. The district prepared two similar plans for the revetments in 1875 and a third in 1876 for the Portage Canal (U.S. ACE, Chicago District n.d., 1873-1928 [designs 13-H-5, 13-H-6, 13-H-7A, tube 72/204, 1875-76 revetment plans]). The left and right sides of photograph WI-104-34 (see also figure 10) which are similar to those prepared in 1875, illustrates the original method employed in the 1850s, in the 1870s, and perhaps as late as the 1920s. In 1876, Captain Lydecker introduced a second system because the space along portions of the canal did not permit the use of piles with ties set back away from the banks illustrated in center of the photograph. The system most commonly employed by the 1870s used two rows of pilings, one row along the face of the bank and a second behind it, the anchor piles, to secure the first row. Two iron ties secured two piles along the face of the canal to one centered anchor pile in the line behind the first row. Sheathing of joined planks was placed behind the front piles and capped with two 12" x 12" timbers. The revetment sat at the

height of the low water line. The modified plan used at least in 1876 placed a brace pile into the bottom of the canal in front of the pilings along the face of the bank. Inclined bracing placed at a forty-five degree angle tied the two rows. Here, the sheathing occurred along the top of the bracing. The pilings along the bank were capped with two timbers (U.S. ACE [Report] 1839-1963 [serial 1722, H. Doc. 1, pt. 2, vol. 2, pt. 2, 1877: 417, plate V]).

Illustrations of piling dating to 1936, 1949, and 1957 (figure 11) show a combination of these two approaches. This version involved three parallel rows of pilings. The front piling somewhat in front of the bank was tied by bracing to the piling along the face of the bank. Sheathing covered the front of the bracing, and timbers capped the piling in the second row. A third row of anchor pilings stood behind the face of the bank (Bambery 1866-1960 [box 9, 1936 map]; Torkelson 1952; WDNR, Facilities and Lands 1951-87 [file: 1958-72, 1957 map]). This system appears to be similar to the one constructed in 1897, the last systematic replacement of timber revetments. This project occurred northeast of the railroad bridge to the Fort Winnebago Lock. The Army Corps appears to have driven three rows of pilings along the bank. The work included driving pilings along the face of the canal bank, placing anchor pilings just behind the face of the bank, anchoring this second row of pilings to the anchor pilings behind the second set, and placing horizontal pine planks along the canal side of the pilings bordering the canal rather than behind them. Additional work on the revetments occurred in 1900 and 1902 (see photograph WI-104-35) (Bambery 1866-1960 [1897: file 6, box 2, p. 152, 232, 250-51, 263; 1901: file 1, box 3, pp. 60-64, 207-208, 246-48; 1902: file 1, box 3, pp. 316-17]; U.S. ACE, Oshkosh 1896-99).

The remains of the revetments now visible along the canal may represent a combination of these revetment types. Without subsurface investigation, it is difficult to determine their precise configuration. Revetments constructed under the aegis of the Milwaukee District of the Army Corps are now visible along four segments of the canal. These locations include the area along the southeast bank between Griffith and Morgan streets and across from Jackson Street; under and just southwest of the railroad bridge near Center Street along the southeast bank; just north of the STH 33 bridge along both sides of the canal; and intermittently north of this location along both sides of the canal south of the Indian Agency House (photographs WI-104-19-21, figures b-c).

The remaining revetments between Griffith and Morgan streets include an intermittent line of single, horizontal timbers at the water line along the southeast bank of the canal. Pilings stand in front of the timbers. The area immediately adjacent to the canal banks is overgrown with trees and grasses. Further back, residences and some industrial buildings occupy the lots. The opposite bank adjoins a residential area. Vertical timbers compose the second area of revetments under the walkway associated with the railroad bridge. Unlike the other revetments which support horizontal timbers, this section appears to have been built specifically in association with the railroad bridge. Just southwest of this section along the southeast bank occurs an additional section of horizontal timbers without visible pilings. Located on both sides of the canal, the two segments of revetments one-tenth of a mile and beginning at three-

tenths (photographs WI-104-19-21) of a mile northeast of the STH 33 bridge are represented by round, vertical timber pilings set in front of the bank and horizontal planking placed behind them rather than in front as in photograph WI-104-34. Both rounded and squared timbers and planks occur in, or are collapsed into, this position. A single row of horizontal members may remain visible because the timbers closest to the bank and to the water, those less likely to dry out, are the ones most likely to be preserved. The segment located three-tenths of a mile northeast of the bridge continues intermittently northeast to a point approximately due south of the Indian Agency House.

Additional structures have been associated with the canal. The records of the State Board of Public Works noted the existence of or the intent to build a towpath along the north side of the canal. The towpath was to measure 10' wide (Wisconsin Board of Public Works 1852: 81). The land survey conducted along the Fox River Improvement in the late 1890s also found reference to this structure in the records of the Wisconsin Board of Public Works (U.S. ACE 1901). Writing in 1941, Louis Schultz recalled a towpath along the edge of the canal (Schultz 1941). This source noted the use of horse boats which carried the lumber along the Upper Fox to the Wisconsin River in 1853 (Wisconsin Board of Public Works 1848-53 [1852: 84]). Thus, although the Fox Waterway was intended for use by steamboats, a towpath was placed along the canal. And, it received at least limited use.

The Fort Winnebago Lock was converted by the Army Corps of Engineers into the current waste weir in 1958-59 (see photograph WI-104-41; figures 9, 11). The remains of the original waste weir occur 900' southwest of the lock along the southeast bank. Probably constructed by 1876, by the 1890s, the structure measured 61'-8" long, 11'-5" wide, and 6'-3" deep and appears to have been at least partially revetted with pine timber. By 1912, the structure was replaced and a bridge was built across it. The Army Corps most recently rebuilt the waste weir in 1940. During the late 1950s when the waste weir was collapsing, the Army Corps backfilled the structure and built up the dike at the location of the existing waste weir to the height of the adjacent canal banks (U.S. ACE [Report] 1839-1963 [serial 2832, Doc. 1, pt. 2, vol. 2, pt. 3, 1890: 2365-66, 2388-89; 1941 [pt. 1, vol. 2]: 1591]; Bamberg 1866-1960 [1912: folder 3, box 3, p. 93; 1913, folder 2, box 4, p. 111]; U.S. ACE, Oshkosh 1896-99; East Central Wisconsin Regional Planning Commission 1948-85 [file: Transfer of Upper Fox to State, 11/2/59]; WDNR, Facilities and Lands 1951-87 [file: Fox River Investigation, 1951-60; 1954 report; and 9/10/58 letter]; Kleist 1987: 31). The site of the waste weir currently remains visible. The stone-lined outlet which permitted water to flow from the southeast bank into a ditch which led into the Fox River above the mouth of the canal is now filled with earth, rubble stone, and a galvanized metal cap. However, a portion of the ditch which connected to the Fox River does remain about 50' southeast of the canal.

In the recent past, debris was periodically removed from the canal. The Wisconsin Department of Natural Resources cleaned the canal in 1970 and 1973. By 1977, the Portage Canal Society provided volunteer labor for this task. The work in 1978 by Manpower Services of Columbia County included tree removal, trimming overhanging trees and brush, spraying of weeds, and disposal of debris

within the canal's banks. The Portage Canal Society and Wisconsin Department of Natural Resources supervised the 1978 project. The Canal Society also performed and sponsored canal clean-up periodically after the late 1970s (WDNR, Facilities and Lands 1958-97 [file: Portage Canal, 1958-75, report dated 7/3/75; file, 1977-78]).

Footbridges, vehicle and railroad bridges, abutments to a railroad bridge, fill and culverts, and recently constructed revetments compose current structures along the canal (figures b-c; photograph WI-104-33). Horizontal, squared, timber revetments line the canal's banks between the footbridge northeast of the Portage Lock and Adams Street (photograph WI-104-16-17). These revetments were constructed during the city's downtown revitalization project between 1986 and 1988 (Foellmi 1997 [11/12]). In 1984, the city erected a wood footbridge across the canal north of the Portage Lock to provide access for senior citizens from the Riverwood Apartments at 215 West Mullett to the downtown area (WDNR, South District 1946-92 [file: 1982-91, memos concerning footbridge, 7/26/83]; Kleist 1987: 31; Portage Ad Hoc Committee on Flood Control 1992: 1, 10-15).

The concrete, low span STH 33 bridge crossing replaced the draw bridge at Center Street between October 1950 and November 1951 (Plaque, STH 33; Galley Studio 1950). The Army Corps provided permission for the city to built the fill and culvert construction between Adams and Thompson in 1954. An earlier bridge did not exist at this location. A similar structure replaced the steel draw bridge crossing at Wisconsin Street in 1959 (figure 16). These structures include an earthen fill extending across the canal between the two streets over a metal pipe culvert with a diameter of about 11.5'.

The Milwaukee and LaCrosse Railroad, later the Milwaukee, Chicago, and St. Paul, crossed the canal just north of STH 33 in 1856. Sometime after this portion of the line was abandoned in 1907, the bridge was removed. The ashlar stone abutments remain along the southeast bank of the canal. The Soo Line currently crosses the canal south of Center Street. In 1937, the railroad replaced the lift bridge then known as bridge C-220 with a 76' vertical lift, steel span bridge with 55' of clearance above the water. Portage contractor William Kutzke constructed the bridge following the 1936 design by the railroad in 1937 and 1938 (Photograph WI-104-58). The railroad removed the counterweights in 1952 and the bridge's superstructure in 1968 (Wisconsin Public Service Commission 1931-51 [1937, file C-42.141]; Portage Daily Register 1/14/37; Columbia County Historical Society 1982; Portage Chamber of Commerce n.d.; Peters 1948: 8; Shank 1982: 49).

The Portage Lock

Initially constructed between 1849 and 1851 under the Wisconsin Board of Public Works (table I), the Portage Lock was most recently replaced between 1926 and 1928 by M.E. White and Company of Chicago. The company followed plans prepared under the direction of E.M. Nisen, Assistant Engineer at the Milwaukee District of the Army Corps of Engineers in June 1926 (U.S. ACE, Milwaukee District 1926c). The district completed the specifications on July 30, 1926 (U.S. ACE, Milwaukee District 1926a). The plans were prepared in five sheets. Sheet one (photograph

WI-104-36) illustrates the site of the lock; sheet 2 (photograph WI-104-37) shows the general plan and elevations; sheet 3 (photograph WI-104-38) indicates the lock gates; sheet 4 (photograph WI-104-39) illustrates the miter sill, snubbing posts and steel plates; and sheet 5 (photograph WI-104-40) shows the operating mechanisms for the gates (photograph WI-104-36-40) (U.S. ACE, Milwaukee District 1926c).

The Portage Lock stands at the west end of the canal adjacent to the Wisconsin River. A large sand flat currently separates the end of the canal from the river. The rear yards of a residential area along West Edgewater borders the lock along the north and a park-like area west of the Riverwood Apartments occurs to its south. The lands adjoining the extreme west end of the lock are covered with low brush. A chain link fence currently surrounds the structure (figure 12, photograph WI-104-35).

The Portage Lock (photographs WI-104-1-15, WI-104-36-40, and WI-104-49-54, figure 13) measures a total length of 209'-0", extends 170'-0" between the quoins posts, and provides an available length between the lower gate recesses and the upper gate of 148'. The total width of the concrete structure reaches 63'-2" while the interior chamber is 35'-2" wide. Between the east gate recess and the west gate, the width of the lock walls in cross-section ranges from 14' at its base to 6.5' at the top. While the interior side of the walls is perpendicular to the floor, the exterior walls angles out away from the lock to provide stability like a buttress. The 3'-6" high floor extends under the wall and 2'-0" beyond the outside edge of the wall along each long side. The floor is keyed to the base of the wall. The base of the lock sits at 770.33' above mean sea level on a base of sand with clay 8' below. The elevations of both miter sills and the breast wall occur at 776.0' above mean sea level. The total height of the floor within the lock is 28'-3". The lock provided a lift of 2.3' (Bamberg 1866-1960 [box 9, 1936 map and plan]; U.S. ACE, Milwaukee District 1926a).

The Milwaukee District provided detailed specifications (U.S. ACE, Milwaukee District 1926a) and plans (U.S. ACE, Milwaukee District 1926c) for the construction of the lock, cutoff walls, wing walls, and short levee. The following description is based on these specifications. The actual construction of the lock appears to have deviated little from these specifications. The need to box-in the springs underneath the lock floor composed the major departure from the original plans. The changes to the lock following construction are also noted.

The specifications required the construction of three 95'-0" long, steel sheet pile cut-off walls along each side of the lock. Two sets were placed at the upper or west end at the end of the lock and opposite the west gate and one set was placed at the lower end of the lock. Continuously interlocking, Lackawanna sheet piles were used. Projecting 18" into the concrete floor, they formed a water-tight diaphragm to protect the lock from flooding and prevent shifting of the sand under the weight of the structure. Concrete walls covered the steel sheet piling. The number nine, square rebar also joined the cut-off wall and lock wall.

The specifications described a 3'-6" thick concrete floor which rested directly on the sand without the use of bearing piles. The floor was poured in six, 32'-9" to 39'-0" sections beginning at the west end of the project. All specified rebar sizes were standard, square 1-1/8" or number nine rebar. Reinforcing bars were to be placed horizontally at 6" centers near the top and at 12" centers near the bottom of the floor slab. A double row of rebar also projected from the floor up into the wall to tie them together. The six floor sections extended as a monolithic structure across the lock and under the side walls. A continuous concrete key with inserted steel plates extended from the floor into the side walls and between the horizontal sections of the floor. The concrete keys projecting between the slabs were intended to prevent shear or shifting between the sections and prevent leakage into the lock.

The plans and specifications indicated the construction of each north and south side wall in six sections corresponding to the floor sections. Construction proceeded from east to west. Along much of the wall, vertical rebar was placed 2'-0" on center and 6" from the surface of outside edge to protect against rusting. The wall sections at each end of the lock included several recesses. Opposing recesses along the walls at the each end of the lock provided spaces for the insertion of stop logs. These recesses measured 15" x 15" in cross-section. The second set of recesses on each wall upstream of each gate received the lock gates with space for the open valves at the base of the gates. Four steel ladders climbed the inside wall of the lock chamber near each gate. Three 8" x 30" high, wrought steel pipes filled with concrete composed the snubbing posts. They were spaced along each wall within the lock chamber. Boats tied to the snubbing posts to secure their position during the locking operation. The top surfaces of the lock walls were finished level with the grade.

The gates closed against the miter sills in a V-shaped formation. Placed at the elevation of standard low water, the miter sills were to be constructed of 12" high steel channels and concrete with the lower channel bolted to the floor. Reinforcing rods tied the concrete portion of the sills to the floor. The rods were placed between 1'-0" and 3'-0" on center. Additionally, a triangular key of 6" high concrete was molded with the floor to provide a stop against which the sill rested. The castings for the lower steel pintels were to be embedded in the concrete to receive each gate in the proper, upright position. Molded monolithically with the floor slab, the 6'-0" wide, vertically reinforced breast wall was to be placed at the upper or west edge of the lock with its top level with the adjacent miter sill. The breast wall sat perpendicular to the lock wall just east of the west end of the gate recess walls. The top was to be finished to permit the stop logs to rest tightly on the concrete.

A pair of steel gates which closed against the miter sills occurred at both ends of the lock. When closed, the resulting V-shape pointed west for both gates, and they opened toward the west or against the current coming into the canal. To form the gate, steel flat plates were riveted to the structural web formed from the horizontal steel I-beams and vertical channels or C-sections. A cover board of a single piece of white oak finished the top of each gate. The hinge mechanisms for the gates consisted of the heel posts which are bolted to the bottom edge of the steel gate. The heel posts were mounted into the heel post

casting and rested on the pintel placed in the miter sill. Each gate was suspended from the top by two heavy turnbuckle straps which extended from a steel pin at the top of the gate to a vertical steel pin placed in a recesses in the lock wall. The anchor rod or gate leveling rod for each gate was a 4" round, 3'-0" long cold rolled shaft (see photograph WI-104-30). It was set horizontally in the anchor rod recess at the top of the wall behind the heel of the gate to hold the turnbuckle suspension rods. The two assemblies formed a "V" against the heel of the gate for the adjustment of the gates to a level position. A .5" steel plate covered each recess.

To create a watertight joint between the gates and the walls and between each pair of gates, the plans provided for white oak hollow quoins and heel and toe posts along each edge of each gate. The toe posts were placed along the interior ends of both gates in each pair. While the gate end of the post was square, the ends which joined were beveled. The heel posts occurred between the outside gate edge of both pair of gates and the oak hollow quoins positioned along the lock wall where the gates were hung. While the gate ends of the heel posts were square, the end toward the quoin was rounded.

The hand operation of the gates was to be provided by the tripod or capstan which sat at the side of the lock wall west of each gate on a hollow concrete platform covered with a steel plate (see photographs WI-104-31-32). The 29'-4", latticed gate spar which attached to the gates near their inner, upper corner ran to the tripod. The recesses in the top of the wall received the gate spars. The turnbuckle suspension rods were placed under the tripods. A detachable hand crank rotated the shaft of the tripod and the spar gear beneath it. These gears meshed with the spars to open and close the gates. The tripods themselves stood on a steel plate over the recesses. When the spars pulled the gates opened, they rode back over the rollers or racks under and slightly behind the tripods and projected well beyond the back of the recesses.

Three valves occurred near the base of each gate. Each valve door was closed with a connecting rod which extended to the closing pinion and lever at the top of the gate. A pipe hand rail along the top of the gate provided access to the valve levers for their manual operation. The specifications stated that the contractor deposit all the patterns with jigs and templates for the castings of parts used at the Portage Lock with the United States lockmaster at Kaukauna. They are now warehoused at Lock Number One in Appleton.

The plans provided for two wood water gauges. The upper, 22'-6" long gauge was positioned along the north wall between the upper stop log slot and the upper or west end of the lock wall so that the zero mark was at the top of the breast wall. Similarly, the 10'-0" long lower gauge occurred along the north wall between the lower stop log slot and the end of the lower wall with the zero reading level with the lower miter sill. The increments along the gauges were marked in Roman numerals.

Two stone and concrete, 35'-0" long masonry wing walls extended west from the upper end of the lock walls. To provide for independent settlement of each structure, the wing walls were to abut but not join the ends of the lock walls.

Facing stone was to be roughly rectangular. Stones were thickly mortared in place. Stone available from the dismantling of the first lock and the paving along the side of the canal were placed in the wall. The new wall was to join with the existing retaining walls along the north side of the canal. The contractor also assumed the responsibility for backfilling behind the lock walls, wing walls, and retaining walls. Puddle clay backfilled the area behind the wing walls. Sand with limited gravel and hardpan composed the fill material behind the lock walls. A short, sand levee 10' in width at its top was to extend from the west end of clay behind the south wing wall to the southeast corner of the curling rink. The upper face of the levee received paving stone produced by the adjacent excavations. This levee keyed into the Portage Levee. Thus, the gates of the Portage Lock were to function as part of the levee (General Engineering Company, Inc. 1991: 5).

While the ends of the second, earlier lock were removed, the stone-filled crib walls sheathed with double 2" x 12", fir planking served as a retaining wall east of the new lock. The walls angled from a 12' width at the base to 6' width at the top. The double thickness of planking also covered the traverse floor beams. The west or upper 80' of the two walls stood higher than the lower 130'. The two sections were connected with steps. The contractor was to repair the north wall which had fallen into the lock in the summer of 1926. Those portions of the north and south wall dismantled to build the new lock were to be relaid so that they join with the east end of the new lock. These sections of the old lock walls were to be reconstructed to their original configurations including the exterior planking and coping timbers and concrete along the top of the walls. A concrete apron was to join the floors between the two locks.

Although the loading calculations were not included with the specifications, they indicated that the design of the rebar size and placement and floor and wall thicknesses attempted to anticipate the stresses placed on the structure. Notes accompanying the specifications indicated that the engineers considered the floor to be heavily reinforced with the number nine rebar placed at 6" on center near the top and 12" on center near the bottom (U.S. ACE 1926a [correspondence w/ specifications]). The large size, tension rebar and closer spacing along the top of the floor and connections into the side walls carried or counterbalanced the weight of the walls on the floor. They were also to withstand the upward, ground water pressure when the lock was dewatered. Such precautions appear to provide for the negative bending moment created to counteract the tensile forces in the center of the slab. Those along the bottom counterbalanced the downward weight of the water which overall was less than the upward forces created by the water pressure and walls. Thus, the number nine tension rebar are spaced farther apart on the bottom to provide for the positive bending moment.

In addition, the operation of the manual gates was balanced by the sheet piling and concrete cut-off walls placed along the outside of the lock walls opposite the gates. The rebar also tied the cut-off walls and lock wall together. In addition, the base of the wall which was more than twice as wide as its top, compensated for the soil pressure along the exterior of the wall and the water pressure when the lock received water. Its shape prevented the wall from overturning. And, the provision of concrete keys and steel plates and rebar

connecting between sections poured at separate times created a monolithic structure better able to resist inward collapse when uneven forces were created by draining the water from the lock.

The concrete specifications also attempted to maintain suitable conditions for concrete work. Each cubic yard of concrete contained six bags of cement, twenty-five pounds of hydrated lime or one-half a bag of lime, 25 cubic feet of gravel, sufficient sand to fill the voids left by the gravel, and sufficient water to permit the dumping of the concrete from the mixer as "uniform plastic mass" (U.S. ACE, Milwaukee District 1926a). The specifications called for the use of a large capacity mixing plant using batch-type mixers capable of handling 375 yards of concrete in eight hours. This capacity enabled the continuous pouring of each floor and wall section. M.E. White used a mixing tower to direct the cement to different areas on the job site. After the mixing of the concrete, buckets or similar machinery were to rapidly convey the concrete to the forms. Chutes were to have a slope greater than one unit vertical to two units horizontal, and the concrete was not to drop vertically for more than four feet. Such directions were intended to ensure against separation of the concrete. The concrete was to be poured before an initial set occurred. Each section of the lock, for example a right or left wall or floor section, was to be contiguously poured to form a monolithic structure without planes of weakness. Additionally, the temperature during the pours were to measure above thirty-three degrees Fahrenheit during the setting of the concrete to ensure the concrete attained its maximum strength. The contractor was permitted to use enclosures and artificial heating to bring the temperature above freezing. This observance of this specification delayed work considerably during the first year of construction (U.S. ACE, Milwaukee District 1926b; U.S. ACE, Chicago District, n.d., 1872-1928 [plans 4-N-28, tube 56/204, sheets 1-5, 1926]; Porter 1926-28).

Prior to conveyance of the Upper Fox including the Portage Canal and its locks to the state in 1961-62, the Milwaukee District agreed to deactivate the locks. Beginning in 1959, it converted the Portage Lock to a water control structure. This work entailed the welding of the gates into a permanently closed position and the removal of all hardware except the valve rods and levers, pipe rails along the top of the gates, and the plates which covered the anchor or leveling rods and the recess below the tripods. The snubbing posts and anchor rods as well as the four ladders located inside each gate were to remain. Some of the anchor rods were later removed and the resulting spaces were filled with concrete. The district removed the gate opening mechanisms, the spars and tripod and associated hardware. The removal of these mechanisms left a rectangular depression west of each gate. The location for their attachment in the upper interior corner of each gate remains. The remaining depressions west of the east gates are covered with the steel plates while those west of the west gates currently lack such a cover. Valve levers along the southeast and the northwest gates are now gone. While the west water gauge remains, the east gauge was removed at an unknown date. The district also lowered the crib walls of the second lock to the east of the current lock to create a one to one slope. The stairs placed along both sides of the second lock remained until at least 1968. They are now removed. Rubble stone probably associated with the rebuilt wall of the second lock now remains scattered along the north bank east of the east gate.

A waste weir which was not described for the construction of the third lock was filled-in to the same height as the adjacent canal banks. A report of 1954 noted that a 15' x 33' wood building near the lock was in poor repair. Not mentioned in the 1959 report, the building was probably removed between these two dates (U.S. ACE, Chicago District 1958-59; WDNR, Facilities and Lands 1951-87 [file: Fox River Investigation Book, 1951-60; Upper Fox Public Access, photographs, 1968]; East Central Wisconsin Regional Planning Commission 1948-85 [photographs of locks, ca. 1960]).

The lock has gradually deteriorated and undergone some additional alteration since it was deactivated in 1959-60. The city constructed a chain link fence around the lock in 1968 as a protective measure (WDNR, Facilities and Lands 1958-97 [file, Portage Canal, 1958-75]; WDNR, S. District 1946-92 [file: 1946-72, letter dated 4/23/68]). The base plates which include the valves of the gates are badly rusted, and holes have rusted through the steel gates in numerous locations. The silt is sufficiently high and the lower portion of the gates have deteriorated so that the valve structures are no longer distinguishable. The hollow quoins and heel and toe posts between the gates and the wall and between each pair of gates are badly rotted. At some gate ends, they no longer remain or a portion of the timber has fallen away. The hollow quoin and heel post at the southeast corner of the lock remains relatively intact. The middle section of the lock's north wall was badly spalled by 1968, and concrete along the south wall has started to spall since that time (East Central Wisconsin Regional Planning Commission 1948-85 [memos by Robs Plains, 7/26/85; 9/11/86]; WDNR, Facilities and Lands 1951-87 [file: Upper Fox Public Access, photographs, 1968]).

The main channel of the Wisconsin River has moved west of the mouth of the canal to the west side of an island. The collection of sediment north of the island has allowed a large sand bar to form between the main channel and the entrance to the canal. As a consequence, little water has entered the canal at low water since at least the late 1980s (General Engineering Company 1991: 5). Finally, because of the poor condition of the gates, the Department of Natural Resources constructed a temporary sand levee across the mouth of the canal in 1992. It stands 150' west of the upper or west gates. The 10'-6" high levee with a top width of 10' has a water control structures at its center (WDNR, So. District 1946-92 [file: Portage Canal, 1992]).

The Fort Winnebago Lock

The Milwaukee District of the Army Corps dismantled much of the Fort Winnebago Lock in 1959-60 to create a waste weir (figures d, 11). The lock is located at the east end of the Portage Canal just west of its juncture with the Fox River. The Indian Agency House and associated buildings sit just to its southwest. No other buildings occur in its vicinity. The structure now sits in a park-like setting with lawns and scattered trees bordering both sides.

The Milwaukee District substantially rebuilt the Fort Winnebago Lock in 1890 as a composite structure (photographs WI-104-42-45). The lock was initially built as a timber structure between 1849 and 1851 and rebuilt in 1858 as a composite

lock. The district rebuilt one wall of the lock after the flood of 1900 in 1900 and 1901 (photographs WI-104-55-56). It renovated the lock in 1936 (Table 1). Thus, the last complete rebuilding of the lock occurred in 1890.

Edward Sargent of the Milwaukee District supervised the rebuilding of the lock in 1890. Redrawing the plans, he based the design of the replacement lock on those prepared for the Montello Lock, a composite lock constructed in 1868 (photograph WI-104-42) (U.S. ACE, Chicago District n.d., 1873-1928 [tube 72/204: 13-G-18, 1890, cost specifications from Montello Lock; plan 13-G-8 based on Montello Lock; plan 13-G-8, redrawn lock plan, ca. 1890]). Sargent hired S.A. Harrison and Company to place fill behind the lock walls and move other materials into place. He used day labor to complete the remainder of the work.

Placed on the foundation of the 1859 lock, a continuous crib with exterior width measurements of 9' formed each side wall. Planking finished the interior walls of the chamber. A facing of 6" of concrete placed between the cribbing and planking was intended to prevent water leakage from the lock. Falls City, Anchor Brand cement manufactured in Louisville, Kentucky, was specified for the concrete. Timber gates closed the lock. They operated on an assembly similar to the Portage Lock. A pin and socket assemblage anchored from the wall and the floor held the gates in place. Hollow quoins prevented leakage at the joints (photographs WI-104-44-45) (U.S. ACE n.d., 1873-1928 [plans 13-G-4 and 13-G-3, tube 72/204, gate details]). Also similar in design although not materials to the later lock were the gate spars, tripods and its associated maneuvering gears, and the valves and valve rod and levers on top of the gates (U.S. ACE [Report] 1839-1963 [serial 2832, Doc. 1, pt. 2, vol. 2, pt. 3, 1890: 2365-66, 2378, 2388-89]; Portage Public Library n.d., ca. 1909-10 [photograph, n.d.]).

The flood of 1900 collapsed the right or south wall of the lock into the chamber. The Army Corps constructed 4' wide, 10' long, and 13' high concrete masonry T-walls which were laid perpendicular to the head or west end of the lock walls to provide structural stability. The fallen right wall was replaced between the hollow quoins with a wood frame filled with dry rubble masonry. The cribbing was faced with a double sheathing of pine planking fastened to the timber framework rather than directly to the stonework. The timber framing was also tied to the rubble wall with iron tie-rods. The opposite wall, breast wall, and wing walls received repair. While the right hollow quoins, gate spars, and floor were replaced, the miter sills, gates, tripod platforms, and maneuvering gears for the valves were repaired. A concrete floor was laid between the miter sills. However, the concrete between the cribbing and planking along the right wall was probably not replaced (Bamberg 1866-1960 [1900: file 1, box 3, p. 60-64, 117-149]; U.S. ACE [Report] 1839-1963 [serial 4282, H. Doc. 2, pt. 4, 1901: 2964-65]).

The Army Corps constructed a single room tool shed by 1896 (U.S. ACE, Chicago District n.d., 1873-1928 [13-C-5, tube 71/204, survey by L.M. Mann, 1896]). In October 1904, the Army Corps erected a 12' square tool house at Berlin and transported it to the Fort Winnebago Lock to replace the first building. The second tool shed was placed along the north bank at the east end of the lock (Bamberg 1866-1960 [1902: file 1, box 3, pp. 392]; U.S. ACE [Report] 1839-1963

[serial 4787, H. Doc. 2, 1904: 1876]].

The 1936 work at the Fort Winnebago Lock, described as an extensive repair, is poorly documented. It involved rebuilding the floor, at least a portion of the timber side walls, and the gates. At the completion of the rebuilding project at a cost of \$38,650, the structure remained a composite lock with dry laid, rubble stone masonry walls held in timber cribbing. Pine planking sheathed the cribbing along the interior of the lock chamber. Wood continued to finish the floor of the chamber. At the top of the lock wall, the width measured 4'-4" across the lock chamber and 6'-0" across the upper or west gate recess. The crib walls were considerably wider at the base than at the top. The inside of the lock chamber measured 34'-8" wide, and the available length, the space between the west end of the east gate recess and the west gate, reached 137'. The lock provided a lift of 6'-5" (U.S. ACE [Report] 1839-1963 [1937 [pt. 1]: 1192]; Wisconsin State Register 1936 [7/7: 2/2]; Meindl 1991: 28; WDNR, Southern District 1946-74 [map of canal, 1957]; Torkelson 1952: 12).

Modification of the lock for transfer by the Army Corps began shortly after November 12, 1959. The agency dismantled the lock including all four wing walls and the east gates and its associated connections. It salvaged the gate hardware. The side walls not required to support the west or upper lock gates, the walls within the east 10' of the upper gates, were dismantled to the water line and the stone was thrown into the lock chamber. These walls were sloped downward at a ratio of one to one and a half to the surface of the lower pool. The banks and area behind the wing walls were sloped at a ratio of one to one. The Army Corps completed most of the grading with a bulldozer. The west gates were cut down to the level of the existing waste weir which was 900' upstream and secured them in a closed position to serve as the new waste weir. The valves in these gates were closed by dumping fill material against the upstream side of the gates. Stone fill was also placed on the east side of the gates and sloped at a one to one ratio from the top of the new waste weir. A portion of the concrete masonry T-walls appear to remain at the west gate. The frame tool shed remained standing through 1960. In 1978, one of the proposed activities for the Manpower Services of Columbia County was the repair of the lock tender's house which may have been the tool shed. This project was not undertaken. The shed no longer stands (U.S. ACE, Chicago District 1958-59; East Central Wisconsin Regional Planning Commission 1948-85 [file: Transfer of Upper Fox to State, 11/2/59; photographs, ca. 1960]; WDNR, Facilities and Lands 1951-87 [file: Fox River Investigation, 1951-60; 1954 report; 9/10/58 letter; 10/26/1960 memo by Robs Plains]; WDNR, Southern District 1946-97 [file: Portage Canal, 1977-78]; Kleist 1987: 31).

Several structures were added to the Fort Winnebago Lock property during or after 1959-60. Wooden landings were installed on either side of the former lock to provide a portage around the structure for recreational canoeists. The construction date of these structures is not known (Meindl 1991: 29). In 1963, the state quitclaimed land south of the Fort Winnebago Lock to the City of Portage. The city in turn leased the parcel to Portage Community, Inc. for fifty years in support of a civic project. Although the project planned for this site failed to materialize, a footbridge was construction to provide access across the

canal to leased property shortly after 1965. Constructed with a wood post and rail superstructure supported by two steel I-beams, the footbridge used the concrete walls at the west gates of the lock as its abutments (Wisconsin Public Service Commission 1954-65 [1965, file 017.36]).

The current remains of the Fort Winnebago Lock may be viewed as an archaeological site. Most of the original footprint of the lock is still visible (photographs WI-104-22-29; figure d). The stone walls which are currently straddled by the footbridge are composed of dry-laid cut stone with a concrete cap east of the footbridge. They represent part of the remains of the lock chamber walls. The cut stone and rubble stone walls with a concrete cap which occur under and west of the footbridge compose the west gate recesses positioned outside the main lock chamber. These walls are 28'-6" in length. An additional west 5'-6" of these walls turn toward each other to form the ends of the gate recess. The total lengths reach 34'-0". The timber base of the west gates, about 20'-6" in length, sits below the footbridge. A line of sheet piling protects the west side of the timbers. Iron bolts project from the upper-most timber along the gate. Iron straps occur at several locations along the timbers. Stone fill almost to the height of the timbers occurs just east of the gates.

Between the locations of the west gates and east gate recesses, the scattered collapse from the dry-laid rubble stone masonry wall projects from the water near the bank. The horizontal timbers associated with the timber cribbing along the interior of the chamber is visible along most of the two banks. This visible wall is one to two timbers high. These walls are now about 38'-6" apart as opposed to the original interior width of 34'-8". At some locations, the rubble fill is visible behind the timber cribbing. The length of the lock chamber between the west gates and the visible indentation which represents the east gate recess currently measures about 130' on either side. The measurements, about 7' shorter than the original available length of 137'-0", may result from the collapse of the end of the wall. A slight indentation in the bank resulting in a width of 39.5' indicates the east gate recess. The remaining stone marks an area 21' along the northwest wall and 25' along the southeast wall. Scattered stone of the wing walls occurs east of these locations. Since this gate recess should also measure about 34', the east end of the lock is not clearly marked.

In addition to the lock, the remains of a grist mill (figure 8) which sat southeast of the lock may be extant. However, the dismantling of the Fort Winnebago Lock with a bulldozer may have destroyed part or all of the site.

SOURCES OF INFORMATION

Because state and federal agencies as well as private companies based primarily in the Appleton and Green Bay area contributed to the construction and operation of the Portage Canal and local agencies were affected by its presence and influenced its operation, research requires the examination of a broad range of repositories and resources.

The Improvement Enterprise Records of the Green Bay and Mississippi Canal Company housed at the Green Bay Area Research Center at the University of Wisconsin-Green Bay provide information about the construction and operation of the Fox Waterway by this company and its predecessors, the Wisconsin Board of Public Works and the Fox and Wisconsin Improvement Company. Examined records include minutes, records of proceedings, and maps (Green Bay and Mississippi Canal Company 1848-1909). This repository also contains the papers of James E. Bamberg, a junior engineer of the Army Corps of Engineers in the Milwaukee District. The portion of this collection most pertinent to the documentation of the canal's construction and improvement includes monthly and annual reports pertaining to operation and care, 1896-1919; improvements, 1896-1919; letters from the Secretary of War 1898, 1922-28; and a portion of the map collection (Bamberg 1866-1960). Three boxes of papers at the Outagamie County Historical Society contain miscellaneous papers relating to the Green Bay and Mississippi Canal Company. Most of their holdings pertain to the property transactions and operations of the company (Baer 1893; Byllesly, H.M. & Company 1926; Day and Zimmermann, Inc. 1928; Fox and Wisconsin Improvement Company 1866a; 1866b; Fox River Improvement Company 1895-1911; Green Bay and Mississippi Canal Company 1866; 1872; 1877; 1973; Hooper 1920; Martin 1851).

The Archives and Manuscripts Division of the State Historical Society of Wisconsin also holds papers relating to the early state and private operation of the canal. The papers of the Fox and Wisconsin Improvement Company (1829-51) also includes miscellaneous papers of companies founded in the 1830s to develop the Portage Canal. The collection entitled Correspondence and Letter Books, Special Topics of the Wisconsin Governors (Wisconsin Governor 1840-1914) incorporates miscellaneous documents related to the development of the canal until the 1870s. The papers of the Wisconsin Public Service Commission provides data about the more recent structures which span the canal. While the Archives and Manuscripts Division preserves most of these papers, a majority of the relevant papers are indexed and microfilmed at the Wisconsin Department of Natural Resources (Wisconsin Public Service Commission 1954-65). The map collection holds a series of manuscript maps as well as county atlases depicting the canal and its adjacent properties. The Wisconsin Visual Archives preserves a large collection of photographs depicting the canal. The Library Division of the State Historical Society of Wisconsin and the Wendt Engineering Library of the University of Wisconsin Libraries maintains contextual histories detailing the development of the Army Corps of Engineers' navigation and flood control improvements, background information about the development of canal and railroad transportation in the nineteenth century, and the engineering technology utilized in the construction of nineteenth and early twentieth century locks and canals.

Most of the data included in the contextual statements provided for the City of Portage are taken from An Intensive Historical, Architectural and Historical Survey of the City of Portage, Columbia County, Wisconsin (McKay 1993a) and two National Register nominations, the Portage Waterfront District and the Portage Retail District (McKay 1993b). Copies are deposited with the Division of Historic Preservation, State Historical Society of Wisconsin.

Government Documents of the State Historical Society of Wisconsin holds the serial set which contains the reports of the federal agencies to Congress including the annual reports of the Chief of Engineers and other reports relating to the activities of the Army Corps (U.S. ACE [Reports] 1839-1963). The reports dating between 1866 and 1912 were indexed by George Zinn (Zinn 1915). After 1908, the annual reports were maintained in a separate series. References to the reports after 1908 are designated by the year, volume, and page number without the serial number. These reports document the Army Corps' studies concerning the feasibility of waterway development along the Fox and Wisconsin rivers beginning in the late 1830s and its operation of the waterway between 1872 and 1961-62. The United States Statutes at Large Containing the Laws and Concurrent Resolutions (United States 1867-1959) provides legal documents pertaining to the federal government's involvement in the canal as the Army Corps began to investigate the operation of the Fox-Wisconsin Improvement in the late 1860s until the property was transferred to the state. State government documents utilized for this study include the Journal of Proceedings of the Wisconsin Legislature and General Laws, Joint Resolutions, and Memorials Passed by the Legislature of Wisconsin (Wisconsin, State of [Laws] 1848-; Wisconsin, State of [Journal of Proceedings] 1848-)). They provide information about state involvement in the development of the canal until 1872, the legislative resolutions and memorials regarding the canal, and state ownership of the property after 1962.

The National Archives and Records Center in Chicago preserves the 189D design of the Fort Winnebago Lock and the 1926 design set for the Portage Lock prepared under the direction of E.M. Nisen (U.S. ACE, Chicago District n.d., 1873-1928 [tubes 56/2D4, 71/2D4, 72/2D4]; U.S. ACE, Milwaukee District 1926c). The regional archives also hold the 1926-28 Journal of Construction of the Portage Upper Locks [sic], a daily log of the work completed at the Portage Lock which was maintained by the Milwaukee District (U.S. ACE, Milwaukee District 1926-28). The Construction Files and Specifications for the Portage Locks and the correspondence file prepared and maintained by the Milwaukee District Office and denoted as file numbers 395556 and 395559 (U.S. ACE, Milwaukee District 1926a; 1926b) could not be located through these numbers at the regional archives. However, the St. Paul District of the U.S. Army Corps of Engineers maintains copies of these documents. Additional documents which were retrieved at the regional archives are entitled the Fox River Subprojects for Operations and Civil Works Project Construction (U.S. ACE, Milwaukee District 194D-53) which provide limited information about repair and construction activities along the canal after 194D. Records documenting the extensive repair of the Fort Winnebago Lock in 1936 were not located. The Federal Archives in Washington also holds several early charts relating to the investigations at the Portage Canal in the 1839, 1867-68, 1874, 1876, and 1890. Most of these documents are available in the

annual reports of the Chief of Engineers or at the regional archives.

Because the annual reports of the Chief of Engineers failed to provide sufficient detail about the waterway after 1912, extensive inquiries concerning the more recent manuscript reports of the Milwaukee District were made at the Detroit District. These inquiries examined possible holdings at the Records Center in Chicago because the Detroit District of the Army Corps currently maintains jurisdiction along the Lower Fox River. Jurisdiction was transferred from the Milwaukee District to the Chicago District in 1955 and from this district to the Detroit District in 1980 (Peterson 1998). Red Peterson at the Kewaunee office and Nick Brittennecker at the Kaukauna office of the Detroit District were also contacted. These investigations did not locate the desired reports. The compilation of the bibliography of papers held at the Kaukauna office had not reached completion at the time of the investigation.

The Wisconsin Department of Natural Resources maintains files of correspondence, memos, and reports dating from the mid-1940s until the present which document its role in the transfer of the property to the state and its oversight of the waterway since 1961-62. Files detailing its involvement with the Portage Canal and the Portage Levee are located in three different sections of the Wisconsin Department of Natural Resources: at the Southern District Office on Fish Hatchery Road in Madison and at the former Bureau of Dam Safety and Water Regulation and Facilities and Lands offices in its Central Office on South Webster in Madison (see WDNR, Bureau of Dam Safety and Water Regulation 1926-70; WDNR, Facilities and Lands 1958-97; 1951-87; WDNR, Southern District 1946-92; 1971-81; Torkelson 1952; U.S. ACE, Chicago District 1958-59).

The East Central Wisconsin Regional Planning Commission maintains a limited number of records primarily relating to the transfer of the canal property to state ownership and its documentation during the 1991 cultural resource survey of the Upper Fox River (Meindl 1991; Vogel 1992; East Central Wisconsin Regional Planning Commission 1948-85). Several repositories in Portage also include data relating to the canal. The Portage Historical Society holds the photographic record of the 1926 to 1928 construction of the Portage Lock by M.E. White and Company (Porter 1926-28). The Portage Public Library maintains a small photographic collection and studies compiled by O.J. Gabriel Peters to promote the deep channel project along the Fox-Wisconsin Waterway (1926a; 1926b; 1928; 1930; 1948; Madison Capital Times 1952). Galley Studio of Portage possesses an extensive collection of photographs documenting the canal. H.V. Tennant of the General Engineering Company, Inc. of Portage oversaw the maintenance of the Portage Levee System for the State of Wisconsin between the early 1920s and 1965-66. This company maintains a number of maps illustrating the levees and several reports detailing the development of the levee system (Tennant 1913; 1923; 1927; 1967; Foellmi 1997; General Engineering Company, Inc. 1926; 1988; Hosely, Frank and Richard J. Koch 1970).

While the remaining features of the Portage Canal were photographed, described, and documented through existing plans, and the ruins of the Fort Winnebago Lock were measured, the historical archaeological resources associated with the canal, including the revetments, Fort Winnebago Lock, and mill site adjacent to this

lock, were not investigated. Before further work in these areas is completed, the potential data available through these resources should be addressed.

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PROJECT INFORMATION

The St. Paul District of the Army Corps of Engineers sponsored the HAER study of the Portage Canal in 1997-98. The individuals providing products to the study include Joyce McKay, Principle Investigator and project historian; Douglas Bergren of The Studio, Polo, Illinois, and Tom Guschl, Rockford, Illinois, who completed the recent views of the Portage Canal and photographic copies of the maps and plans; Fred Galle of Galley Studio, 222 West Cook St., Portage, Wisconsin, who provided photographic copies of historic views; and Jerry Foellmi, Engineer, General Engineering, Inc., 412 East Slifer, Portage, Wisconsin, who provided engineering and descriptive data for the project.

The Programmatic Agreement among the St. Paul District of the U.S. Army Corps of Engineers, the Advisory Council on Historic Preservation, and the Wisconsin State Historic Preservation Officer regarding the Wisconsin River at Portage, Wisconsin, Flood Control Project stipulated that the Army Corps complete detailed documentation of the project area to preserve an understanding of the historic and technological significance of the property and provide interpretive materials. The project requires the upgrading of the Portage Levee which ties into the Portage Lock at the west end of the Portage Canal. Section 401(a) of the Water Resources Development Act, Public Law 99-662 of November 17, 1986, authorized construction of the levee project. As indicated in the General Design Memorandum of March 23, 1993, plan 2 of the authorized levee alignment stipulates the construction of the levee across the mouth of the Portage Lock rather than lock modifications (U.S. ACE, St. Paul District 1992 [1993-94]: 1, 18). This property was found to be historically significant in 1977 when it was entered onto the National Register of Historic Places. Under the regulations for the Advisory Council on Historic Preservation (36 CFR PART 800) which implements Section 106 of the National Historic Preservation Act (16 U.S.C. 470f) and Section 110f of the same Act (16 U.S.C. 470h-2(f)), projects affected by such federal undertakings should undergo documentation.

Figure 1: Location of the juncture of the Fox and Wisconsin rivers at Portage, Wisconsin (U.S. ACE, St. Paul District 1983: 3).

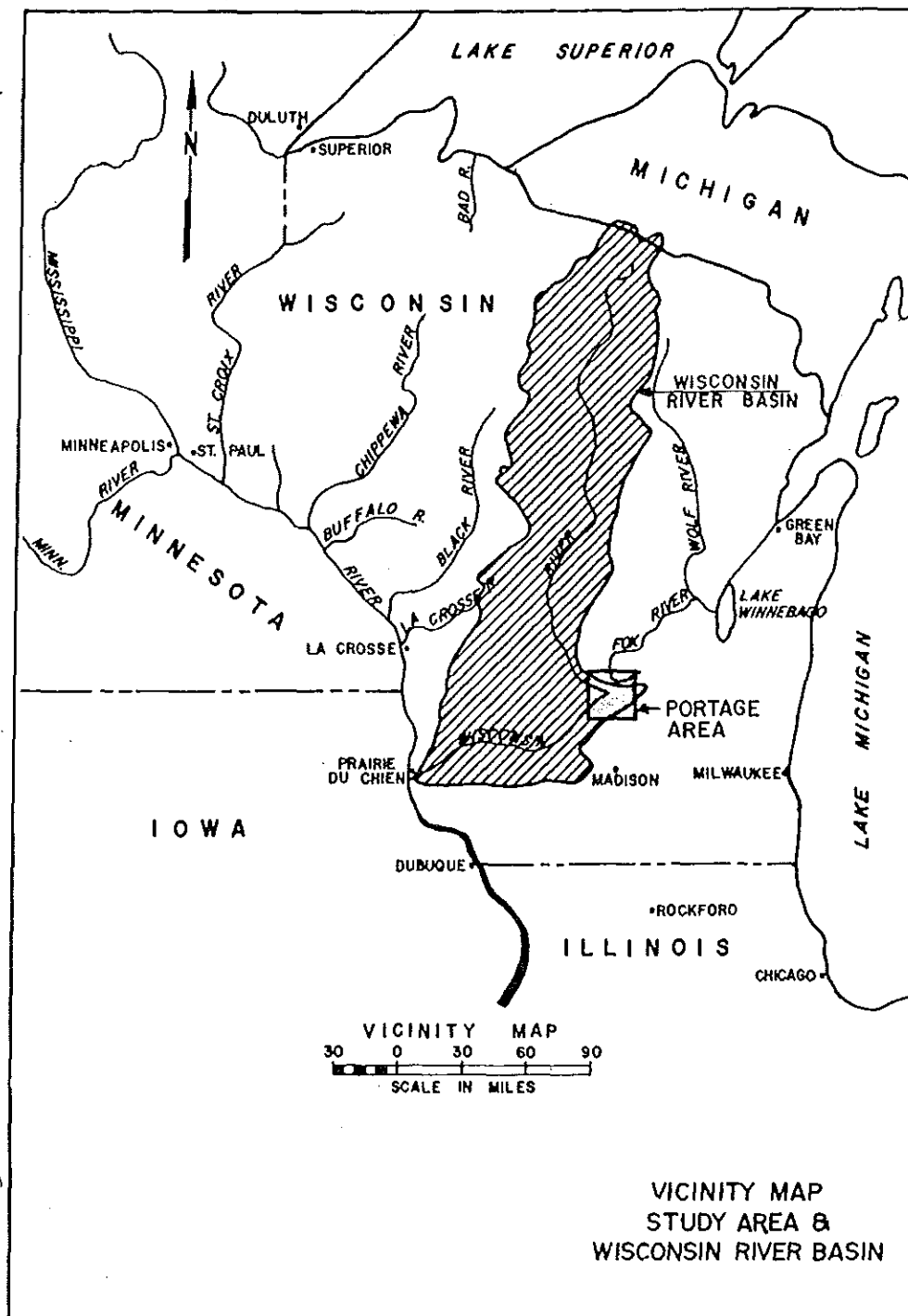
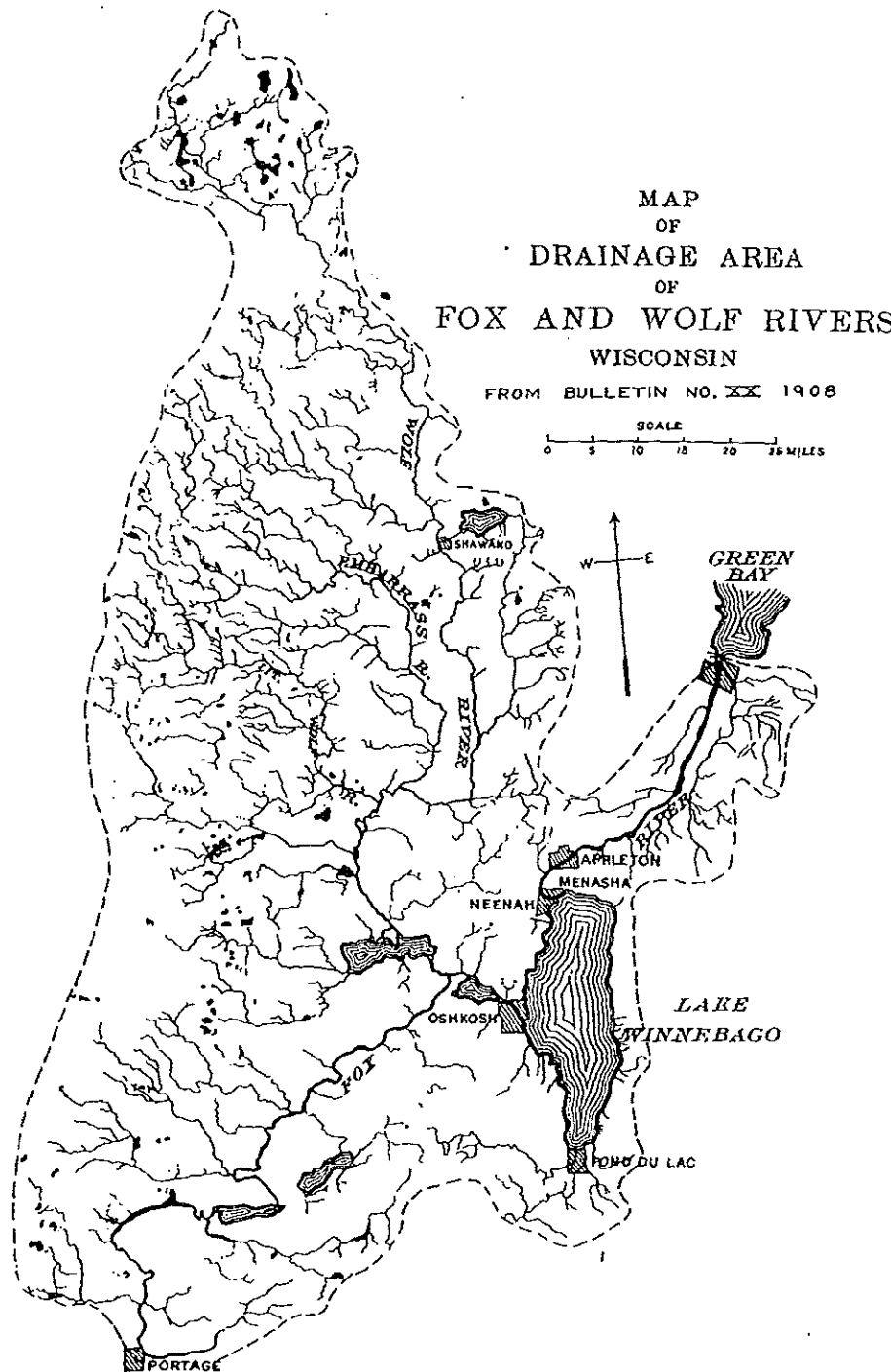


Figure 2: Drainage area of the Fox and Wisconsin rivers (Whitbeck 1915: plate 4).



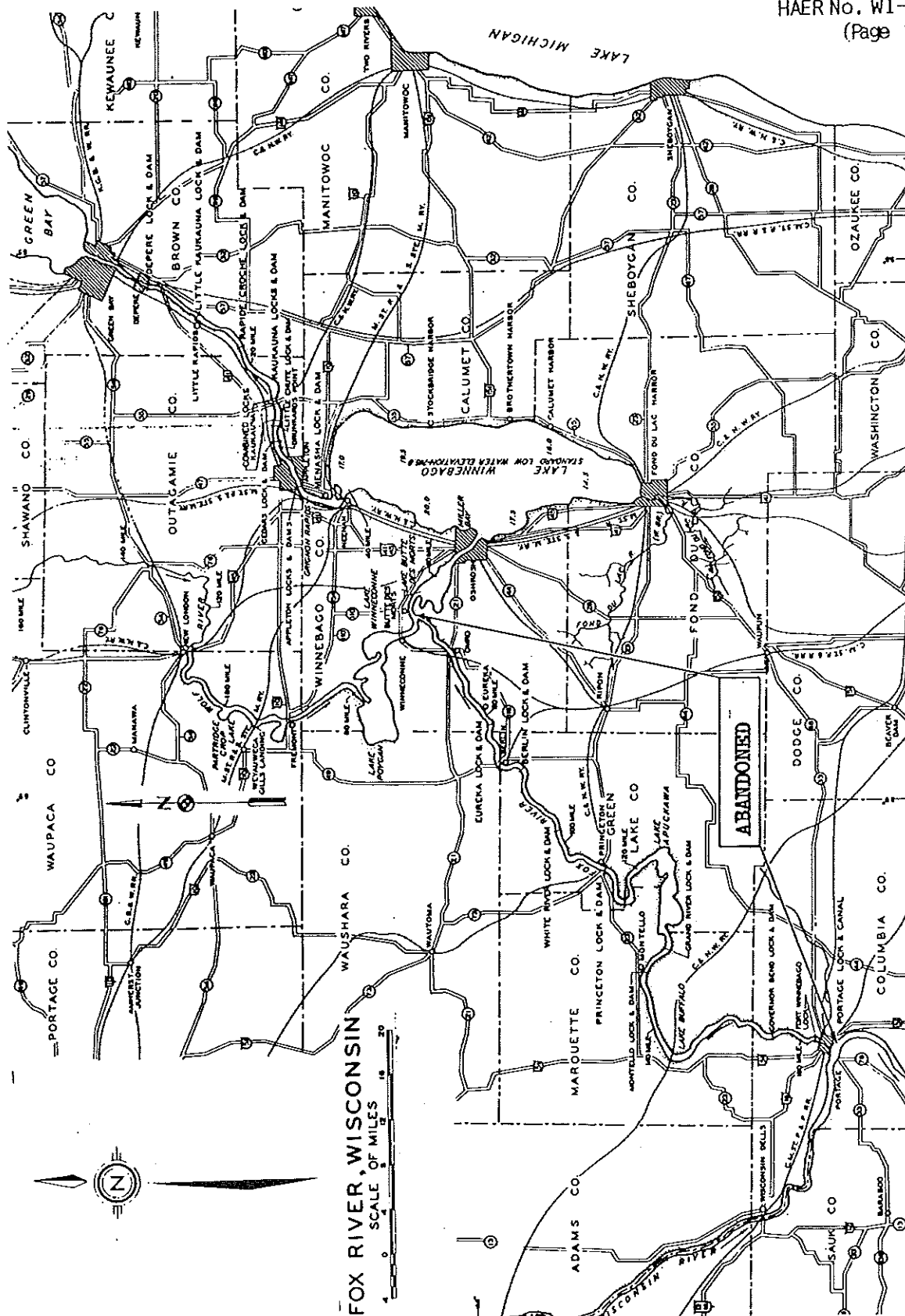


Figure 3: Locks along the Fox Waterway (U.S. ACE, Chicago District 1958-59).

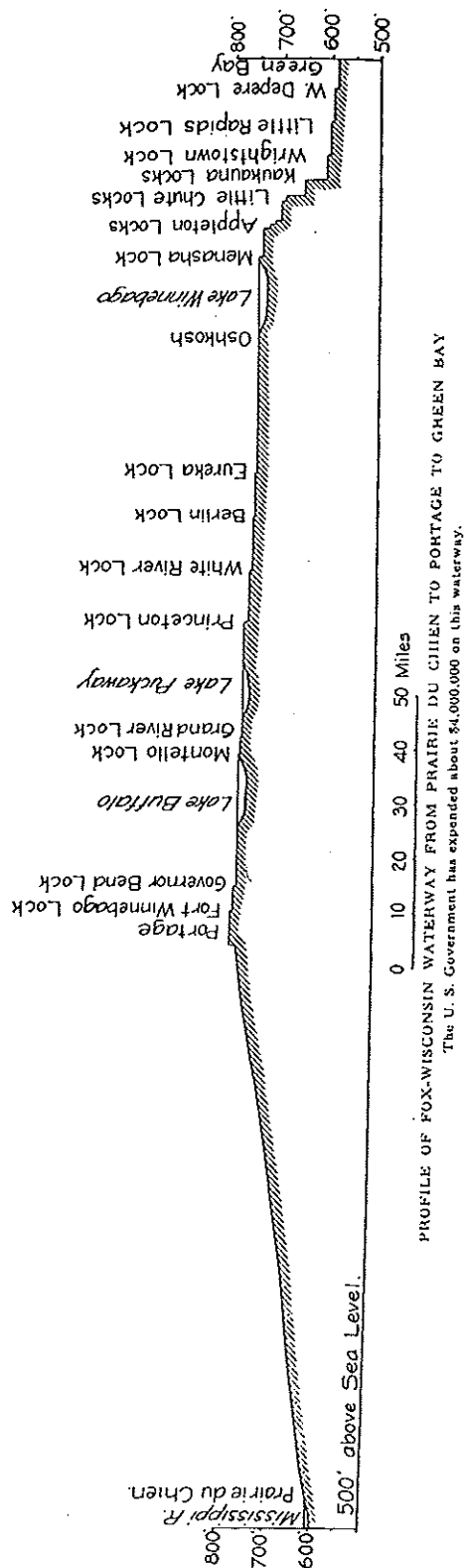
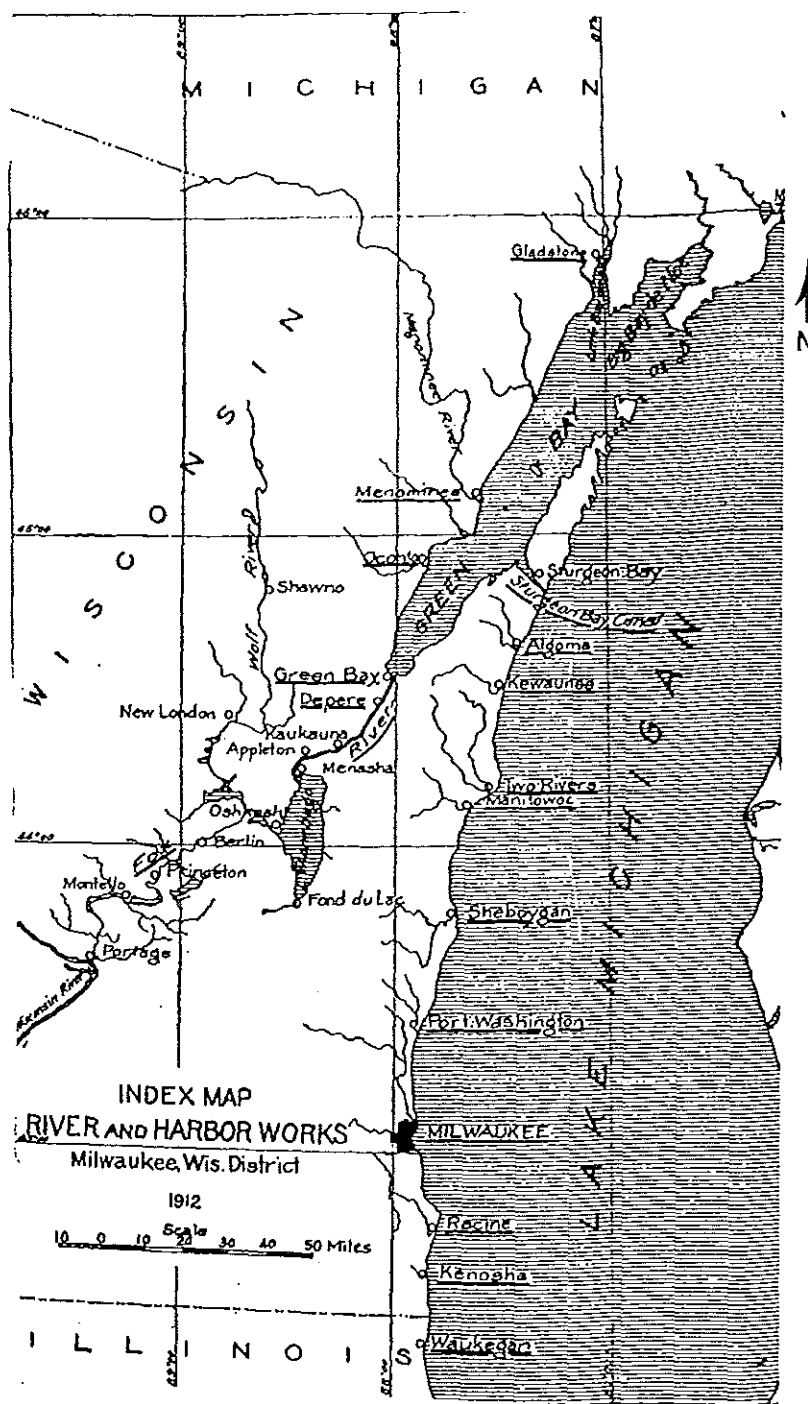


Figure 4: Diagram showing the summit level of the Fox-Wisconsin Waterway at Portage (Whitbeck 1915: plate 8).

Figure 5: Schematic map of the Milwaukee District, U.S. Army Corps of Engineers in 1915 (Zinn 1915: 1296).



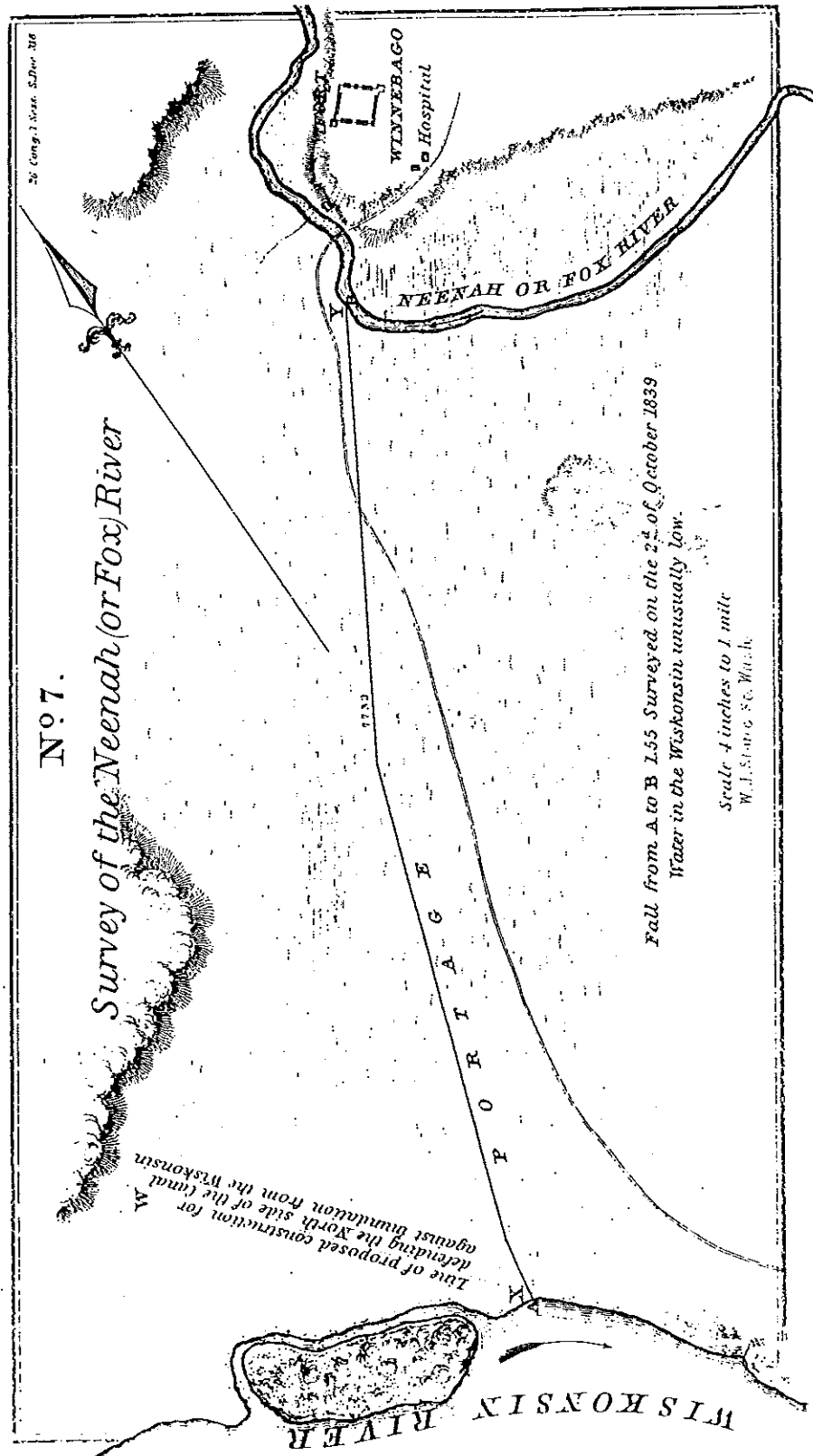


Figure 6: Thomas Jefferson Cram's map of the Portage from his survey of the Fox River (U.S. ACE [Report] 1839-1963 [serial 359, S. Doc. 318, 1840: plate V]). No scale.

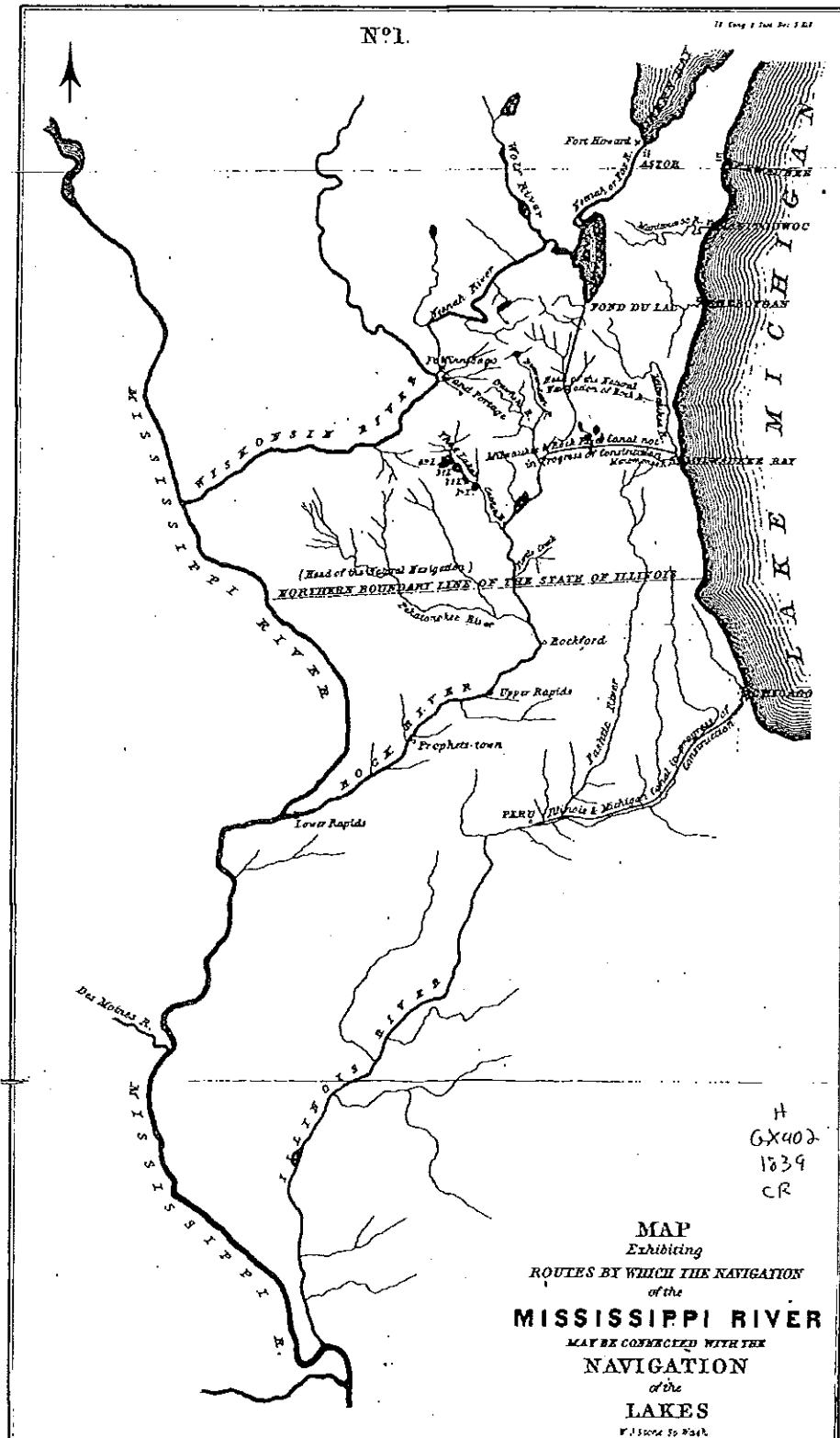


Figure 7: Potential routes connecting the Mississippi to Lake Michigan, 1839 (U.S. ACE [Report] 1839-1963 [serial 359, S. Doc. 318, 1840: plate 1]). No scale.

Figure 8: Diagram of a portion of the Fort Winnebago Military Reserve showing the Fort Winnebago Lock and adjacent mill. The map probably predates 1876 (U.S. ACE, Chicago District n.d., 1873-1928 [71/204, 13-C-2, n.d.]). No scale.

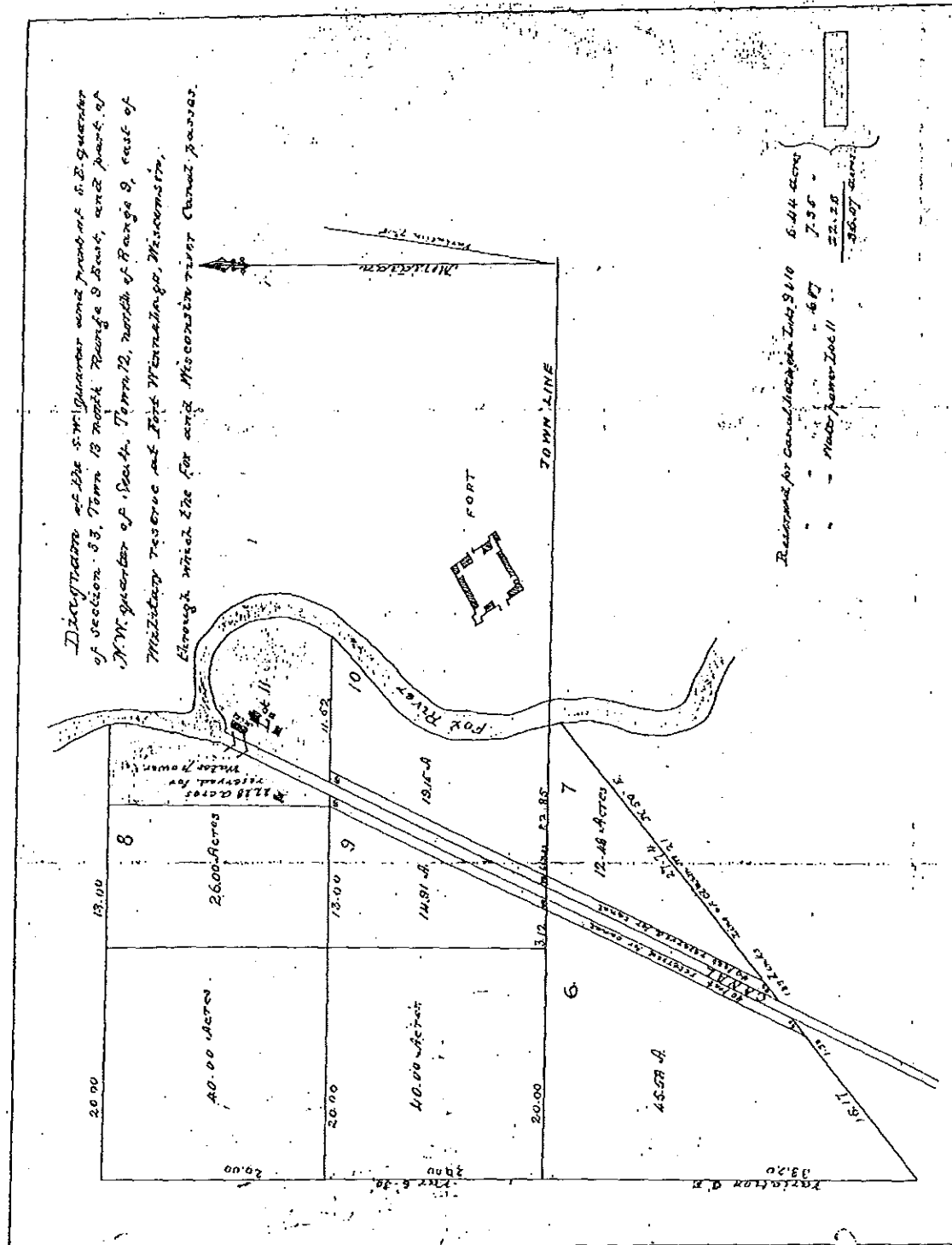
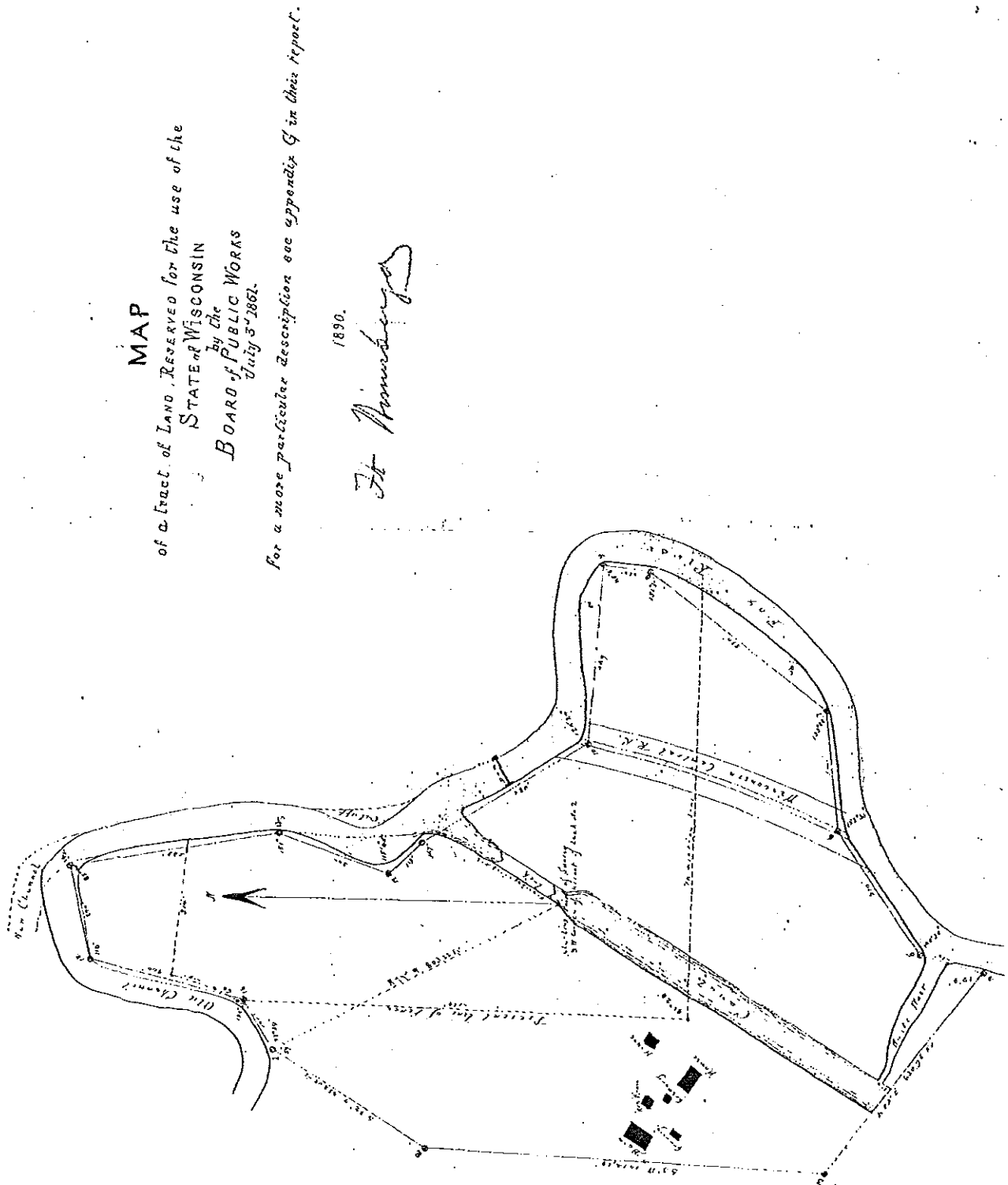
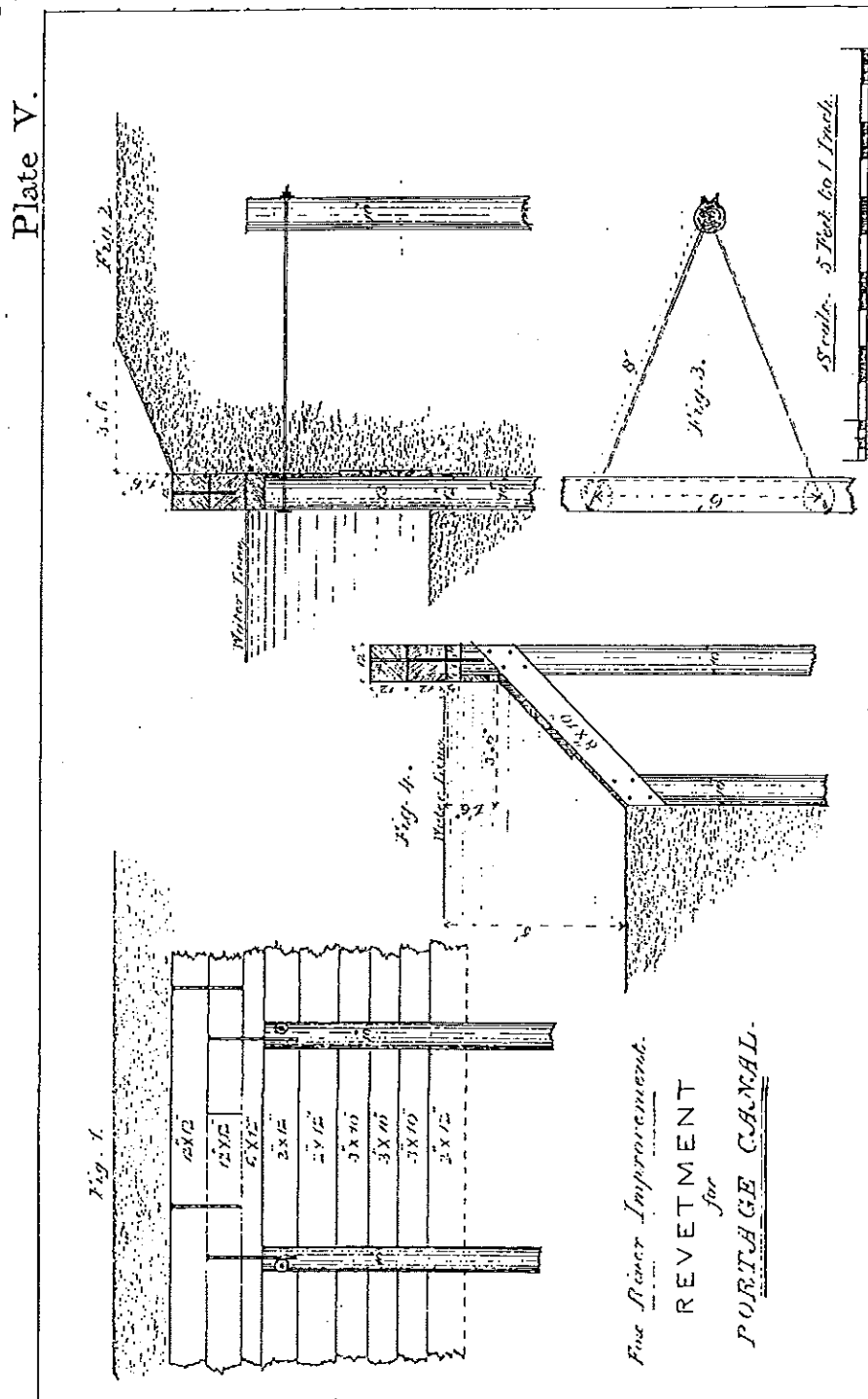


Figure 9: Tract reserved for the state by the Board of Public Works, July 3, 1851, showing the Fort Winnebago Lock, waste weir, and dam, 1890 (U.S. ACE, Chicago District n.d., 1873-1928 [71/204, 13-C-1, 1890]). Scale: 1" = 400'





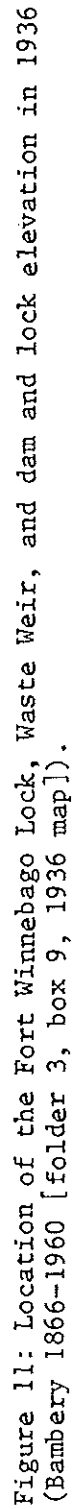


Figure 11: Location of the Fort Winnebago Lock, Waste Weir, and dam and lock elevation in 1936 (Bamberg 1866-1960 [folder 3, box 9, 1936 map]).

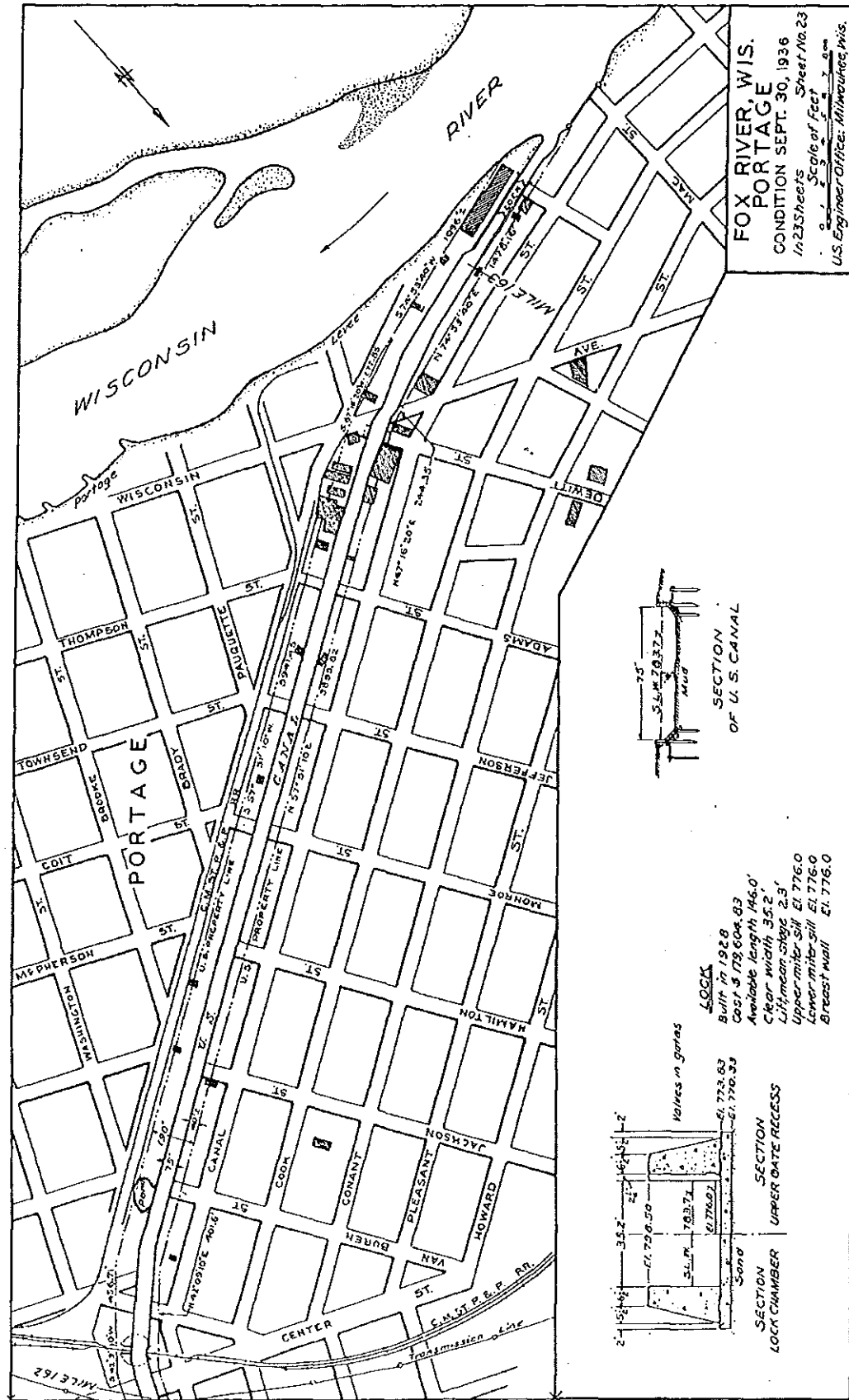


Figure 12: Location of the Portage Lock and Curling Rink just southeast of the lock and lock elevation in 1936 (Bamberg 1866-1960 [folder 3, box 9, 1936 map]).

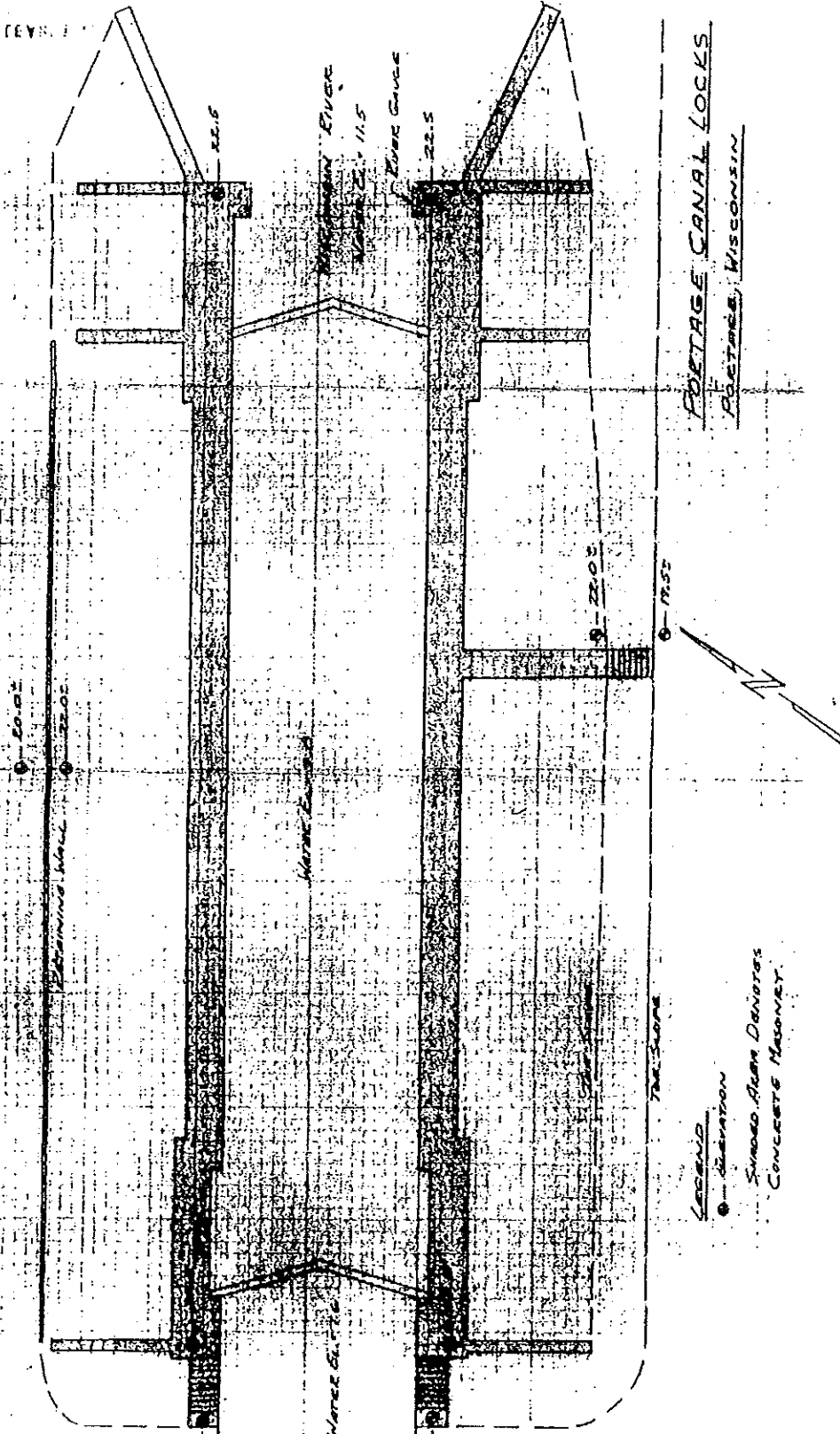
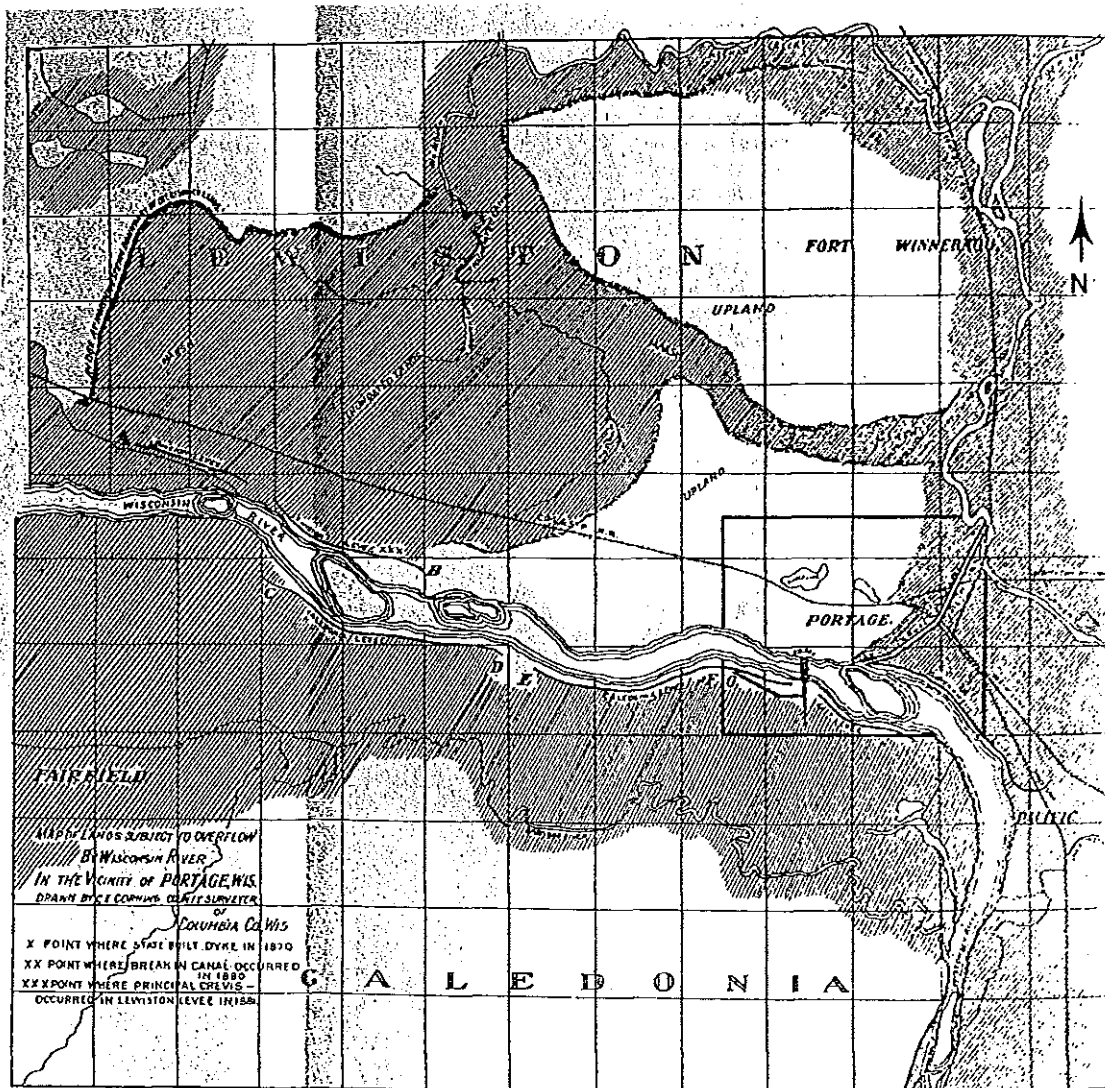
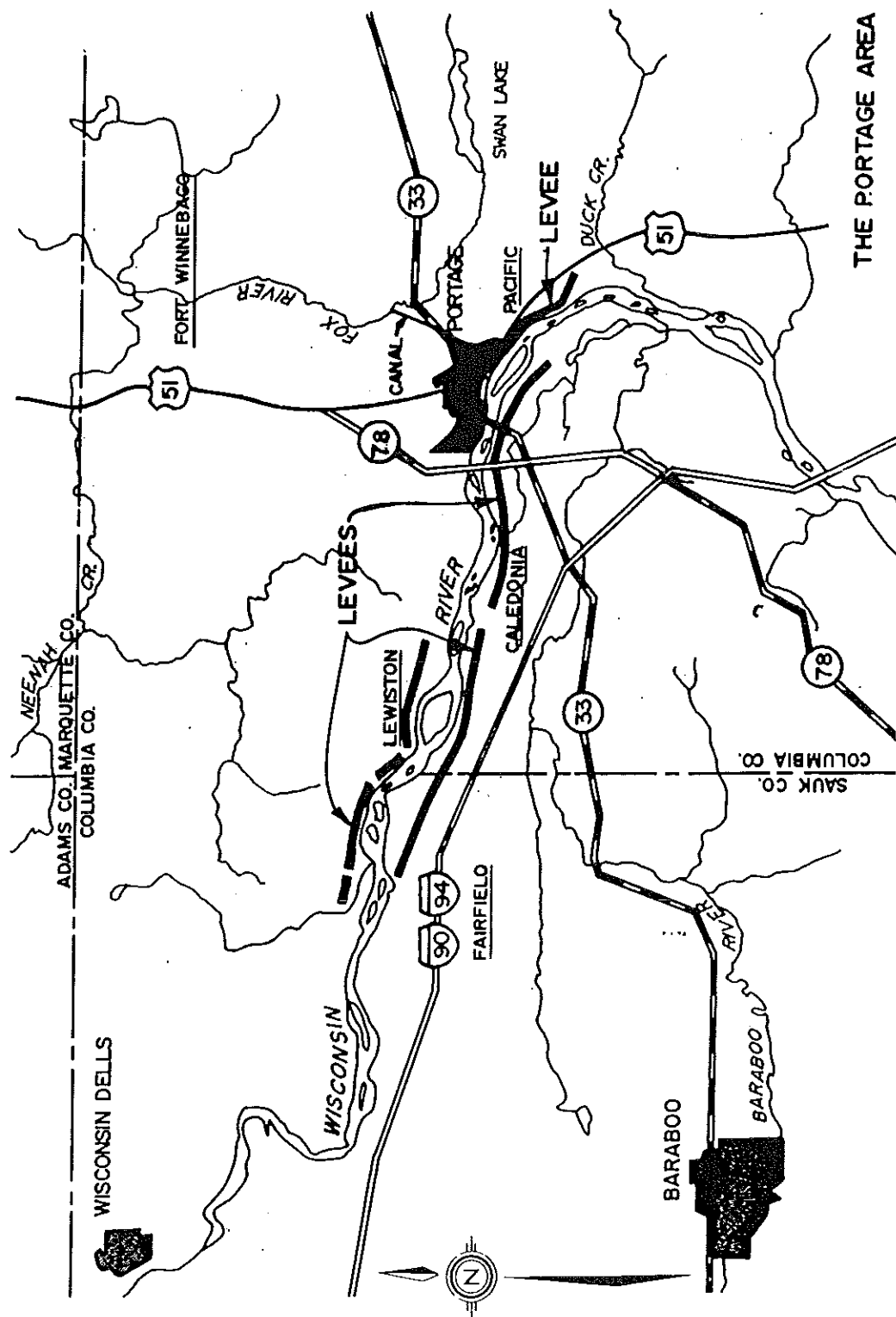


Figure 13: Diagram of the Portage Lock by the Department of Public Works in Feb. 1968 (WDNR, Facilities and Lands 1951-87 [file: U.S. ACE, Upper Fox Public Access, 1968]). Scale: 1" = 35'

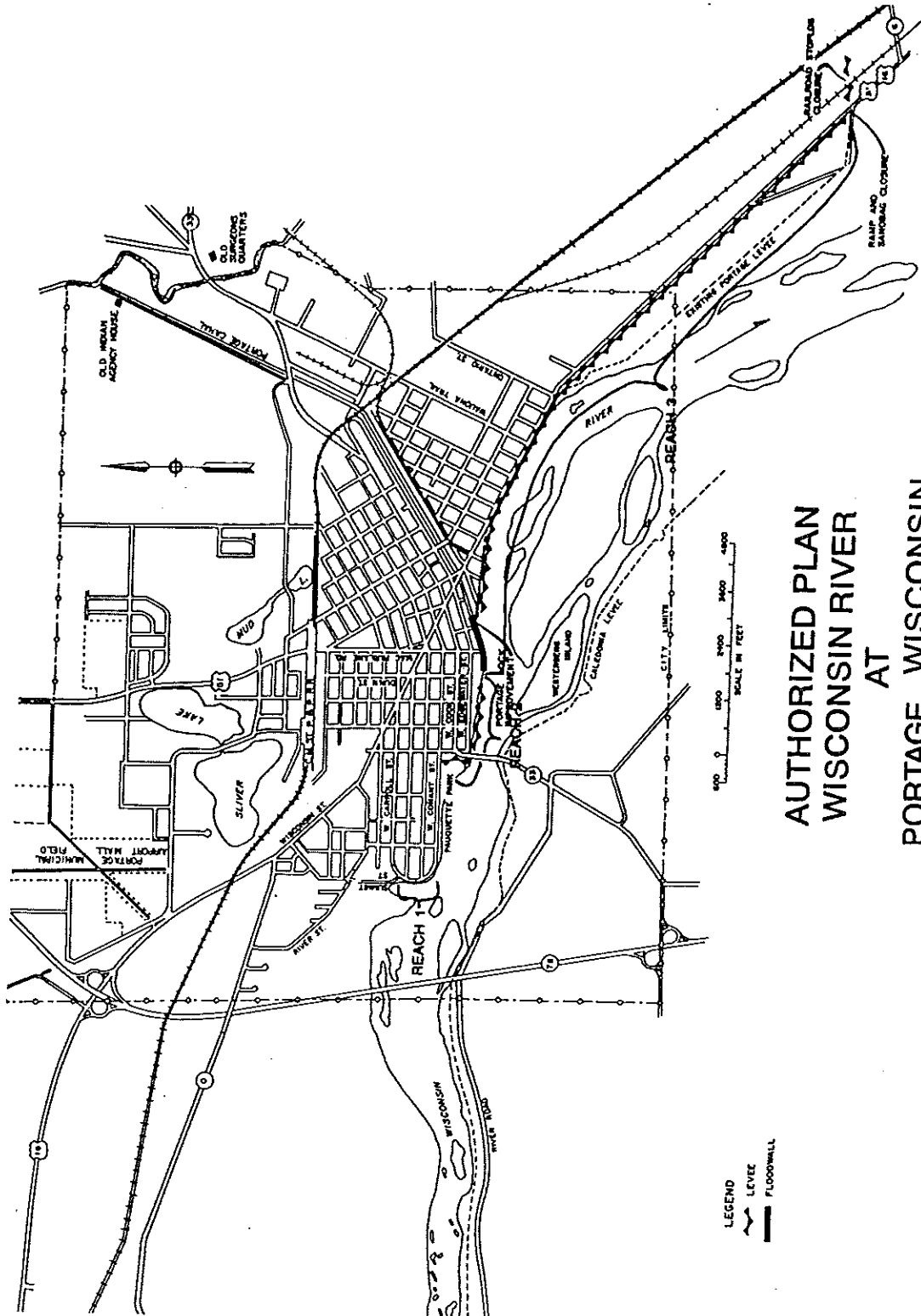
Figure 14: The Portage Levee System in 1901 (U.S. ACE [Report] 1839-1963 [serial 4039, S. Doc. 110, 1900-01: between 4-5]). No scale.





THE PORTAGE AREA

Figure 15: The Portage Levee System showing the Portage, Caledonia, and Lewiston levees in 1983 (U.S. ACE, St. Paul District 1983). No scale.



AUTHORIZED PLAN WISCONSIN RIVER AT PORTAGE, WISCONSIN

Figure 16: Authorized plan for the Portage Levee to be erected near the Portage Canal in 1997-98 (U.S. ACE, St. Paul District [1993-94]: 15).